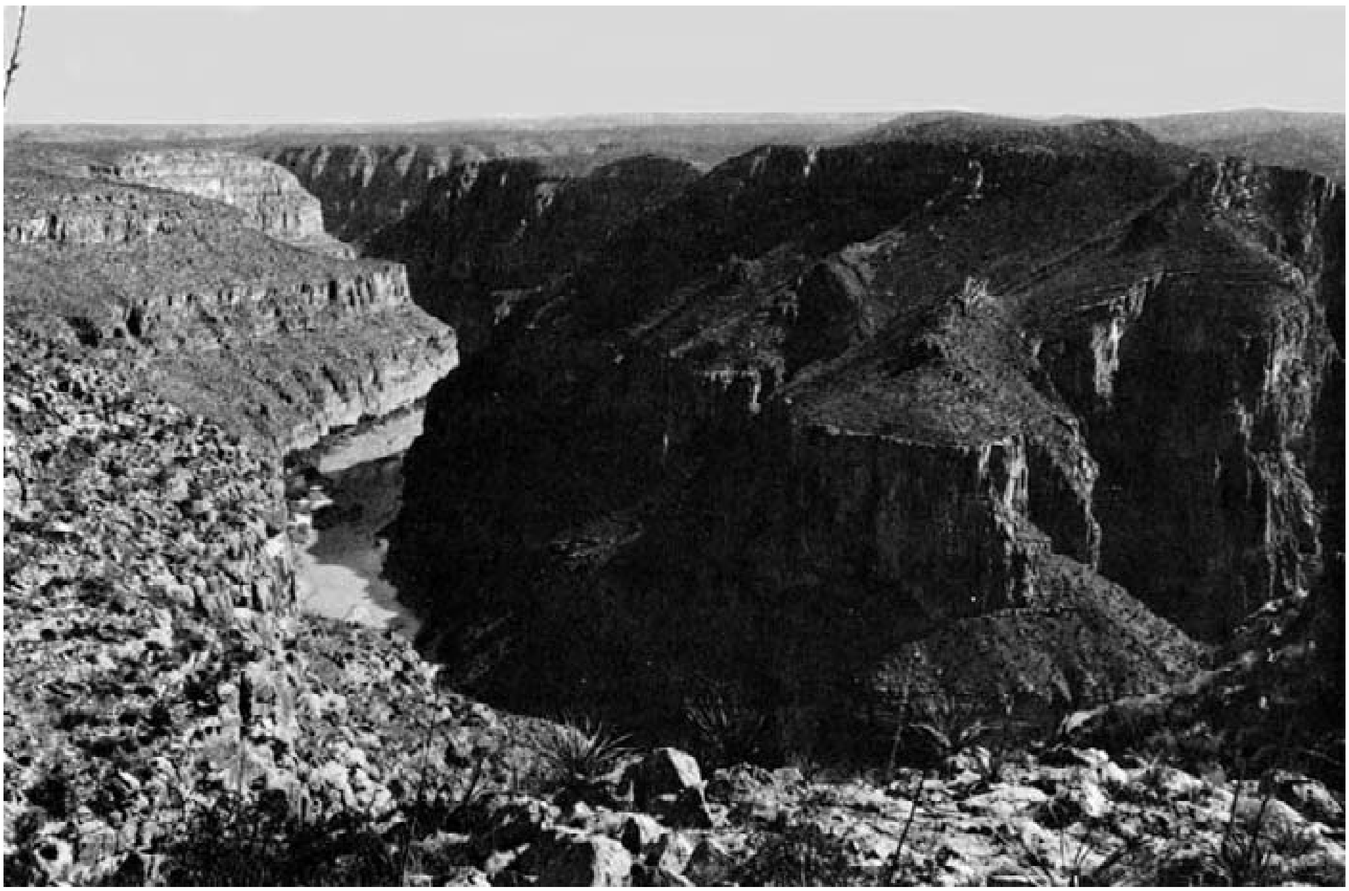
SOIL SURVEY OF

Terrell County, Texas



ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated March 1974. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Texas Agricultural Experiment Station

Major fieldwork for this soil survey was done in the period 1960-64. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1965. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Rio Grande-Pecos River and the Trans-Pecos Soil and Water Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Terrell County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification for dryland and irrigated crops and the range site classification of each soil. It also shows the page where each soil is described.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers, ranchers, and others can learn about use and management of the soils and suitability of the soils for range from the soil descriptions. Also given in the soil descriptions is a description of the vegetation on each range site.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Terrell County will be interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County."

Cover: Rio Grande Canyon, the boundary between Mexico and Terrell County. Lozier soils are in the foreground.

Contents

Issued March 1974

SOIL SURVEY OF
TERRELL COUNTY, TEXAS

BY AUGUST J. TURNER AND ROBERT E. FOX,
SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE,
IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

TERRELL COUNTY is located in southwestern Texas (fig. 1). The Pecos River forms part of the eastern boundary and the Rio Grande forms the southern boundary.

Figure 1.—Location of Terrell County in Texas.

The total area of the county is approximately 1,530,240 acres, or 2,391 square miles. The elevation above sea level ranges from about 1,200 feet in the southeastern corner to 3,700 feet in the northwestern corner of the county. The entire county is underlain by marine limestone which has been deeply cut by streams and rivers. The topography consists of broad, level plateaus and rolling hills to steep hills and canyon walls with a few long, narrow valleys along tributaries of the Rio Grande and Pecos Rivers.

Soils in Terrell County are used primarily for production of natural forage for livestock and wildlife. About 1,520,000 acres, or 99 percent of the agricultural land in the county, is in range. Sheep and goats are the chief live-stock, and most of the agricultural income is from the sale of lambs, wool, and mohair.

A significant acreage on valley floors is suitable for pasture if it is improved. In 1965 approximately 2,000 acres in the county were mainly used to produce supplemental pasture and winter feed for livestock.

About 1,000 acres are irrigated and are used mainly for supplemental pasture and to produce winter feed for live-stock. The irrigated soils are deep, well-drained, nearly level soils on uplands and bottom lands. The Dev, Gila, and Glendale soils are on flood plains and low terraces along the rivers or streams. Reagan and Sanderson

soils are in valleys. Irrigation water is obtained mainly from large springs near the Pecos River and from the Rio Grande. The water of the Pecos River is of poor quality and generally not suitable for irrigation. The water supply from wells is insufficient for irrigation needs.

In 1960 Terrell County had a population of 2,600, and 2,136 lived in Sanderson, the county seat. Dryden is the only other town in the county. Transportation routes are U.S. Highways 90 and 285, Texas Highway 349, and the Southern Pacific Railroad.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Terrell County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Ector and Reagan, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Reagan silty clay loam is the only phase of the Reagan series in Terrell County.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, streams, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Terrell County. These are soil complexes and soil associations. A soil complex consists of areas of two or more soils or land types, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils or land types, and the pattern and relative proportions are about the same in all areas. The name of a

soil complex consists of the names of the dominant soils or land types, joined by a hyphen. Ector-Rock outcrop complex is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Lozier-Upton association is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Badland is a land type in Terrell County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Terrell County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Terrell County are discussed in the following pages. The terms for texture used in the title of the association refer to texture throughout for major soils.

1. Ector-Rock outcrop association

Moderately steep to steep, very shallow stony loams and stony clay loams and rock outcrops

This association is characterized by moderately steep to steep, hilly soils and steep soils on canyon walls. The areas are made up of very shallow stony loams, stony clay loams, and rock outcrops.

Ector soils make up about 75 percent of this association and Rock outcrop about 15 percent. Small areas of Upton and Lozier soils and other soils make up the remaining 10 percent. This association occupies about 44 percent of the county.

Ector soils consist of very shallow stony loams and clay loams over limestone bedrock. Rock outcrop consists of limestone. Upton and Lozier soils are on mesas or hills.

This association is used as range. The soils are too stony and shallow to be suited to crops or pasture. Hazard of water erosion is severe if the soil is not protected by a grass cover.

The association is better suited to raising sheep and goats than for cattle. There are some areas that have little grass because of heavy grazing. Most of the acreage has a thin to moderate overstory of sotol and redberry juniper.

2. Ector-Lozier association

Nearly level to steep, very shallow, gravelly, flaggy, or stony loam and clay loams

This association consists of sloping to steep soils on hills and nearly level soils on mesas and divides. These soils are very shallow over limestone bedrock.

Ector soils make up about 65 percent of this association and Lozier soils about 15 percent. Areas of Upton, Glendale, Gila, and other minor soils make up 20 percent of this association. This association occupies about 22 percent of the county.

Ector soils are rolling to steep and are on hills. Lozier soils are nearly level to sloping and are on mesas and hills. Upton soils are on the foot slopes of the steeper hills and nearly level divides. Glendale and Gila soils are along intermittent streams (fig. 2).

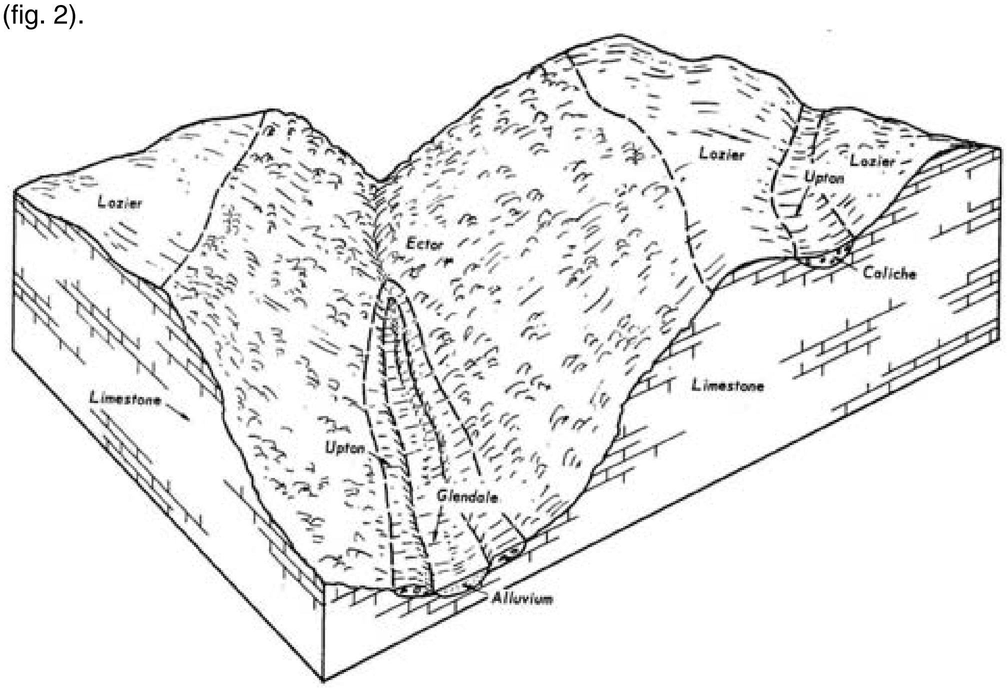


Figure 2.—Relationship of soils in association 2.

The association is used mainly as range. A variety of shrubs and woody plants grow on these soils. These soils are too stony and shallow to be used for pasture or crops.

3. Sanderson-Reagan association

Nearly level to gently sloping, deep gravelly loams, gravelly clay loam, and silty clay loam

This association consists of deep, nearly level to gently sloping soils in valleys. These soils are fertile, and they receive runoff water from adjoining stony hills.

Sanderson soils make up about 38 percent of this association, Reagan soils about 29 percent, and Upton soils about 13 percent. Areas of Dev, Glendale, and other minor soils make up the remaining 20 percent. This association occupies about 18 percent of the county.

Sanderson soils occupy foot slopes and fans below the limestone hills and are slightly higher than Reagan soils. Reagan soils are nearly level silty clay loams. Upton soils are on mounds or ridges and on foot slopes of steeper adjoining hills. Dev, Glendale, and other minor soils are scattered throughout the association (fig. 3).

This association is used mainly as range, but much of it is suitable for pasture and irrigated crops. About 5 percent of the association is pasture. Only a few small areas are irrigated.

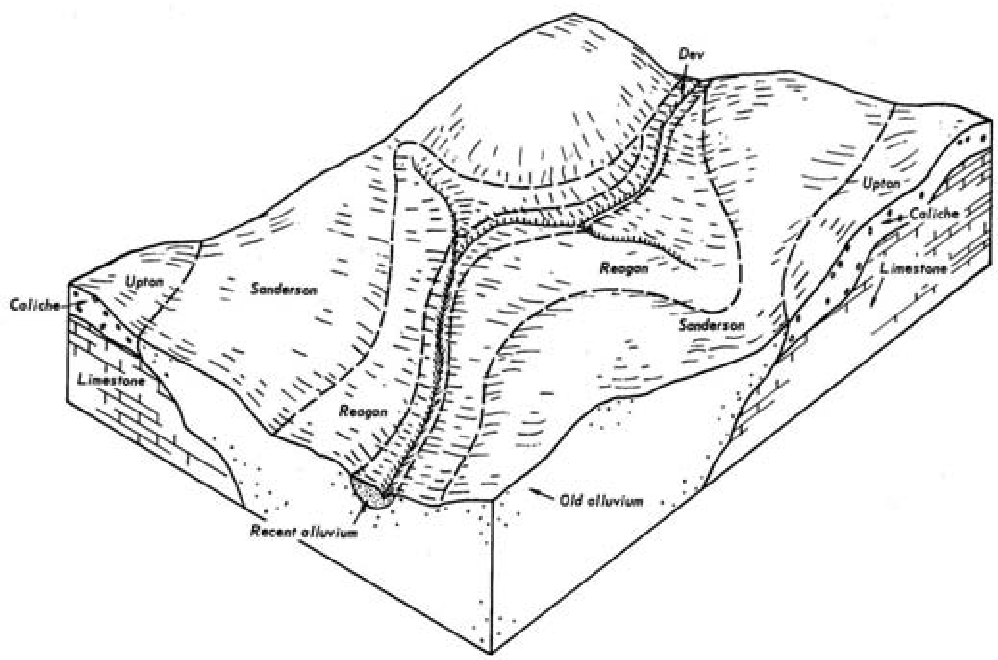


Figure 3.—Relationship of soils in association 3.

4. Upton-Lozier-Reagan association

Nearly level to hilly, very shallow to deep, gravelly or flaggy loam and silty clay loams

The areas of this association are broad erosional plateaus with low hills, ridges, plains, and flats.

Upton soils make up 35 percent of this association, Lozier soils about 20 percent, and Reagan soils about 13 percent. Minor areas of Dalby and other soils make up the remaining 32 percent of this association. This association occupies about 10 percent of the county.

Upton soils are shallow gravelly loams over hard caliche. They are on ridges and fans. Lozier soils are very shallow, gravelly and flaggy loams over limestone bedrock. They generally are on hills. Reagan soils are deep silty clay loams on plains (fig. 4).

Because of shallowness, Upton and Lozier soils are not suited to pasture and are used only as range. Reagan and Dalby soils are deeper and are suited to pasture; however, most areas are used as range.

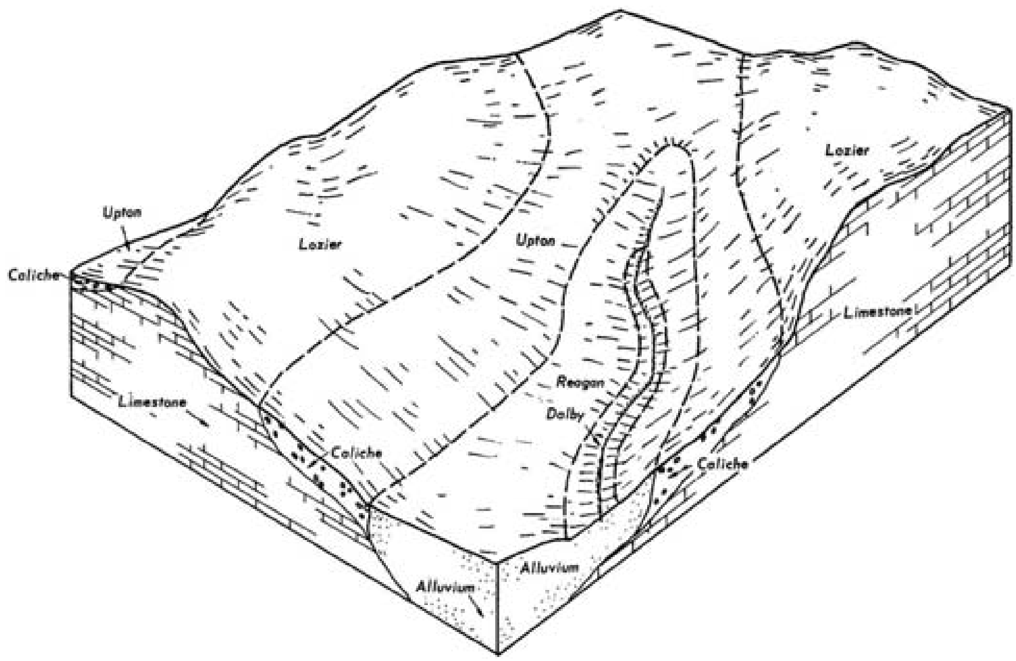


Figure 4.—Relationship of soils in association 4.

5. Lozier-Upton association

Nearly level to steep, very shallow and shallow gravelly loamy and clay loams

This association is characterized by rolling to steep flagstone hills.

Lozier soils make up 40 percent of the association and Upton soils 35 percent. Minor areas of Gila, Glendale, and Sanderson soils make up the remaining 25 percent of the association. This association occupies about 6 percent of the county.

Lozier soils are very shallow flaggy loams over lime-stone bedrock. They are sloping to steep and are on hills. Upton soils are shallow gravelly loams over hard caliche. They are on foot slopes of hills. Gila and Glendale are on flood plains and low terraces of streams. Sanderson soils are on the lower parts of the foot slopes and fans below the steeper hills (fig. 5).

This association is used for range. Vegetation consists mainly of annual vegetation and creosotebush that has no grazing value. Much of the acreage in this association lacks a perennial grass cover.

Descriptions of the Soils

In this section the soils of Terrell County are described in detail and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless it is specifically mentioned otherwise, it is to

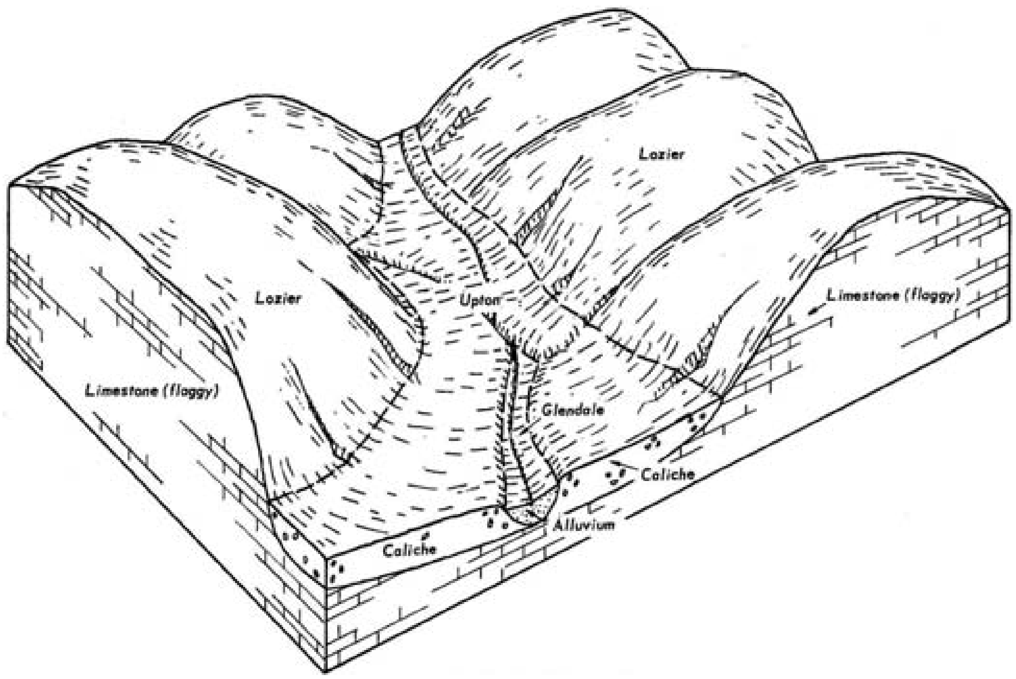


Figure 5.—Relationship of soils in association 5.

be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs. The soil colors given are for dry soils unless otherwise indicated.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the soil series is representative for mapping units in that series. If a given mapping unit has a profile in some ways different from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. The description of each mapping unit contains suggestions on how the soil can be managed.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Badland, for example, does not belong to a soil series, but nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page for the description of each dryland or irrigated capability unit or other interpretative group can be learned by referring to the "Guide to Mapping Units" at the back of this survey. The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual *(10).*

Badland

Badland (Ba) consists of gently sloping to moderately steep, narrow, clayey hillsides. This land type is mainly of the Grayson formation and the clayey alluvial apron that extends a few hundred feet from the base of the hills (fig. 6). In places there are a few narrow, shallow gullies. Slopes range from 1 to 12 percent.

Figure 6.—Badland supports only a few woody plants of no grazing value.

The surface layer ranges from 12 to 24 inches in thickness and consists of brownish-yellow clay. It contains carbonate and sulfate salts and iron oxides. In places the surface has a 2- to 8-inch mantle of fragments weathered from the limestone cap. This weathered surface material is calcareous and is underlain by clayey shale.

This land type supports a few widely scattered desert plants of little or no grazing value. Examples of these plants are mesquite, allthorn, lechuguilla, and chino grama. Excessive runoff of water occurs on sealed clayey surfaces. Areas of Badland are not suited to range. They are scenic and are well suited to recreational uses, as wild-life habitat, and as a source of water. Capability unit VIIIs-1, dryland; not placed in a range site.

Dalby Series

The Dalby series consists of deep, nearly level clays. These soils formed in old alluvial sediment in slightly depressed drainageways and on flats. In a representative profile the surface layer is brown calcareous clay about 6 inches thick. The next layer, about 28 inches thick, is reddish-gray calcareous clay that is very firm in the upper part and firm in the lower part. The next layer, about 16 inches thick, is light reddish-brown silty clay that contains about 2 percent calcium carbonate concretions. Below this is light reddish-brown clay loam that extends to a depth of 70 inches.

These soils are used as range, but they are suited to pasture and irrigated crops.

Representative profile of Dalby clay (100 feet west of the east fence and 0.35 mile north of the southeastern corner of the Dryden Airfield):

A1—0 to 6 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 4/2) moist; compound, moderate, medium, subangular blocky and platy structure; slightly hard when dry, firm when moist; calcareous; moderately alkaline; clear, smooth boundary.

AC1—6 to 18 inches, reddish-gray (5YR 5/2) clay, reddish brown (5YR 4/3) moist; moderate, medium, angular blocky structure; very hard when dry, very firm when moist; a few intersecting slickensides; a few pebbles and grains of limestone; calcareous; moderately alkaline; diffuse, wavy boundary.

AC2—18 to 34 inches, reddish-gray (5YR 5/2) clay, reddish brown (5YR 4/3) moist; weak, medium, angular blocky structure; hard when dry, firm when moist; a few intersecting slickensides; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—34 to 50 inches, light reddish-brown (5YR 6/3) silty clay, reddish brown (5YR 4/3) moist; structureless; hard when dry; contains about 2 percent, by volume of strongly cemented concretions of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary,

C2—50 to 70 inches, light reddish-brown (5YR 6/3) clay loam, reddish brown (5YR 4/3) moist; structureless; calcareous; moderately alkaline.

The A1 horizon ranges from 4 to 10 inches in thickness and is brown to reddish brown in color. The AC horizon ranges from 20 to 38 inches in thickness and is brown to reddish gray in color. The C horizon is brown to reddish gray in color. Texture ranges from silty clay to clay loam. Depth to the C horizon ranges from 24 to 48 inches.

Dalby clay (Da).—This soil is in slight depressions in drainageways and on flats (fig. 7). Slopes are mainly less than 1 percent but range to 2 percent. Most areas of this soil are irregular, long to oval shaped, and range from 40 to 100 acres in size. The surface has scattered small depressions a few inches in depth. Many cracks occur if the soil is dry. Included in mapping are spots of Reagan silty clay loam.

Dalby soils take in water readily if they are dry and cracked but very slowly if they are wet. Surface drainage is slow. Available water capacity is high. The hazard of water erosion is slight. Most areas of this soil receive runoff from adjoining soils.

Dalby clay generally is not suited to dryland farming because of low rainfall. Areas that receive additional water by drainage or by water spreading are suitable for pasture. Successful pasture or hay crops can be established and maintained if management, is good.

Irrigated Dalby clay is well suited to pasture grass and grain sorghum. It has a clay lower layer that impedes the movement of water. Careful management of the soil and regulation of the irrigation water are needed. The soil compacts under cultivation or heavy grazing. Growing high residue-producing crops and returning the residue to the soil help maintain good tilth.

The potential plant community is 50 percent decreasers and 50 percent increasers. The major decreasers are cane bluestem, side-oats grama, and vine-mesquite. The main increasers are tobosa and burrograss. The common invaders are mesquite and a pricklypear.

Overgrazing on this soil results in an increase of tobosa. The estimated potential air-dry herbage yield on range in excellent condition is 900 pounds per acre during favorable years and 600 pounds per acre during unfavorable years. Capability unit VIs-1, dryland, and IIs-1, irrigated; Clay Flat range site.

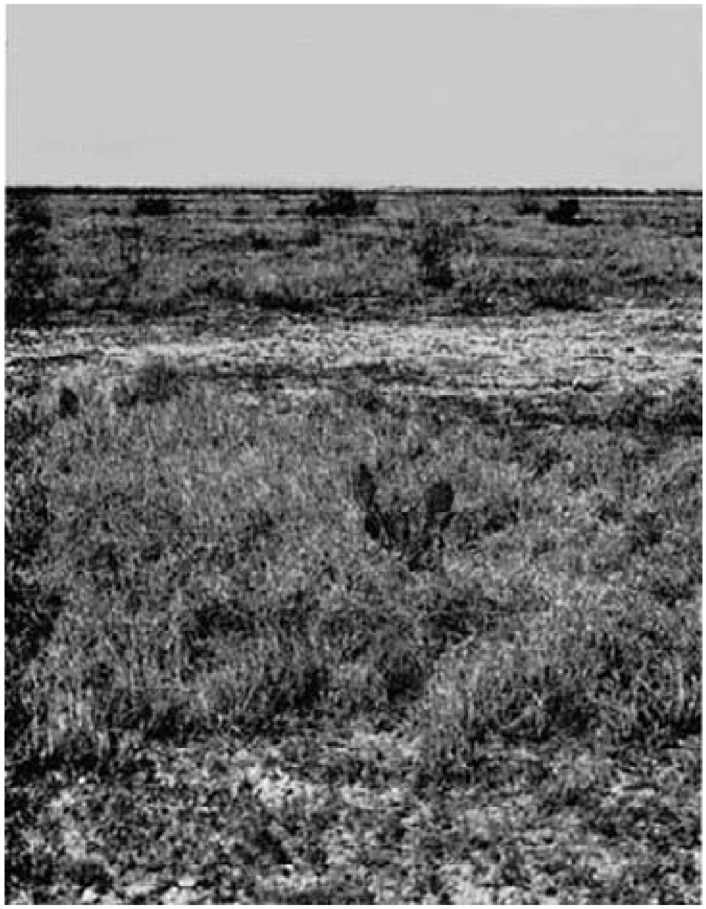


Figure 7.—The grass is mainly tobosa on this area of Dalby clay.

Dev Series

The Dev series consists of deep, level to nearly level, gravelly soils that formed in recent alluvium derived from limestone. They are on low terraces and flood plains of streams.

In a representative profile the surface layer, about 22 inches thick, is grayish-brown very gravelly loam. The underlying material is pale-brown very gravelly loam to a depth of about 50 inches.

Representative profile of Dev very gravelly loam (in an area of Dev association, in a pasture 200 feet east of the bridge on State Highway 349 crossing Dry Creek 31.4 miles north-northeast of Dryden):

A1—0 to 22 inches, grayish-brown (10YR 5/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky structure; hard, friable; 55 percent, by volume, of subrounded limestone fragments, mostly less than a half inch in diameter; calcareous; moderately alkaline; diffuse, wavy boundary.

C—22 to 50 inches +, pale-brown (10YR 6/3) very gravelly loam, brown (10YR 4/3) moist; structureless; 75 percent, by volume of subrounded limestone fragments, mostly less than 1 inch in diameter; a few thin strata of 90 percent gravel; a few specks and films of lime, mainly on fragments; calcareous; moderately alkaline.

The A horizon ranges from grayish brown to brown in color. Texture ranges from loam to clay loam, but 35 to 65 percent of the A horizon is coarse fragments. The C horizon is pale brown to very pale brown in color and is 50 to 85 percent coarse fragments.

Dev association (De).—This association consists of 50 to 70 percent Dev soils, 20 to 30 percent Glendale soils, and 10 to 30 percent gravelly and stony stream-washed materials. This association occupies long, narrow areas along intermittent streams.

Dev soils are level to nearly level. They have a grayish-brown very gravelly loam surface laver about 22 inches thick. The underlying material is pale-brown very gravelly loam (fig. 8).

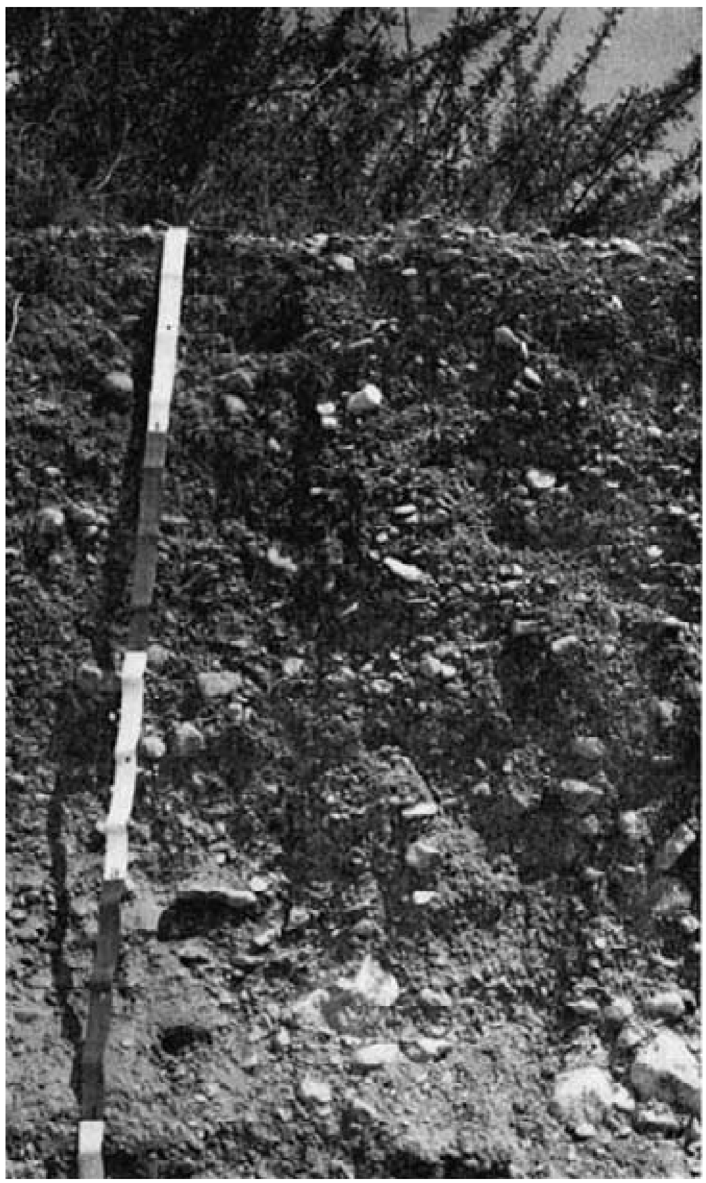


Figure 8.—Profile of Dev soil.

Glendale soils are level to nearly level. They have a light brownish-gray clay loam surface layer about 14 inches thick. The underlying material is very pale brown friable clay loam that is stratified with thin layers of loam, silty clay loam, and sandy loam.

The areas of gravelly and stony stream-washed materials occupy stream channels. This material is mainly lime-stone pebbles and stones. It supports very little vegetation.

These soils are well drained. They receive water from adjoining areas and are frequently, but very briefly, flooded (fig. 9). In areas not protected from flooding by a grass cover, these soils are highly susceptible to erosion.

Figure 9.—Dev association between the hills in the background and the dry wash in the foreground.

Nonirrigated Dev soils generally are unsuited to crops because of low rainfall and susceptibility to damage by flooding. Areas that receive additional water by drainage or by water spreading are suited to pasture. Pasture or hay crops can be established and maintained successfully if management is good.

Irrigated Dev soils also have severe limitations that restrict their use. They have low available water capacity, and because of their location, require protection from floodwaters. For a description of the Glendale soils, refer to the Glendale series.

The potential plant community is 55 to 65 percent decreasers. The major decreasers are cane bluestem, side-oats grama, Arizona cottontop, vine-mesquite, and plains bristlegrass. The major increasers are blue grama, tobosa, and buffalograss. Common invaders are mesquite, catclaw, pricklypear, and annuals.

Overgrazing of this association results in a rapid increase in mesquite and other brush. Severe erosion in gullies is a problem.

The estimated potential air-dry herbage yield on range in excellent condition is about 2,250 pounds per acre during favorable years and about 1,000 pounds per acre during unfavorable years. Capability unit VIw-1, dryland, and Vw-1, irrigated; Bottomland range site.

Ector Series

The Ector series consists of nearly level to steep, gravelly and stony soils, very shallow over limestone. These soils are on plateaus and hills.

In a representative profile the surface layer is dark grayish-brown gravelly loam about 8 inches thick. Below this layer is fractured hard limestone.

Representative profile of Ector gravelly loam (in pasture in an area of Ector soils, 100 feet west of State Highway 349, 14 miles north of the intersection of State Highway 349 and U.S. Highway 90 at Dryden) (fig. 10):

Figure 10.—Profile of Ector gravelly loam.

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; many limestone fragments (60 percent, by volume), increasing in amount with depth; about half of limestone fragments are less than 1 inch in diameter, and in lower half of horizon the fragments are coated with secondary carbonates on lower side; a few limestone fragments 7 inches across the long axis; calcareous; moderately alkaline; abrupt, irregular boundary.

R—8 to 15 inches +, fractured hard limestone that has a hardness of about 4 on Mohs scale; cracks and fractures are partially sealed with reprecipitated calcium carbonate; a seam of dark earth $^1/_8$ inch thick is present in some cracks.

The A horizon ranges from dark brown to grayish brown in color and is 4 to 12 inches in thickness. Texture ranges from loam to clay loam, but 35 to 80 percent of the A horizon is limestone and caliche fragments. Thin, hard caliche coatings on fragments are common especially on the bottom.

The limestone bedrock generally is fractured and has a thin caliche coaling.

Ector soils (Ec).—These soils are on plateaus and hills and have slopes of 5 to 20 percent. In places the hills have a few sharp shallow breaks. The amount of rock outcrop ranges from 5 to 20 percent. These soils have the profile described as representative of the Ector series, except the texture of the surface layer ranges from gravelly loam to gravelly clay loam.

Included in mapping are a few areas of Upton and Sanderson soils.

Ector soils have a low available water capacity. Surface runoff is rapid.

These soils are too stony and shallow to be used as pasture or for crops and acre used as range. Because of the stones and shallowness, plants benefit from light rains, but during a heavy rain most of the water runs off.

In the grassland vegetative zone, the potential plant community is a mixture of grasses, forbs, and browse plants. About 60 percent of this community consists of such decreasers as side-oats grama, green sprangletop, cane bluestem, bush sunflower, kidneywood, menodora, feather and black dalea, and plains bristlegrass. The main increasers are perennial three-awn, black grama, fall witchgrass, slim tridents, and sotol. Common invaders are lechuguilla, juniper, persimmon, red grama, catclaw, and annuals.

Overgrazing of Ector soils results in a rapid decrease in green sprangletop and cane bluestem, and if overgrazing continues, three-awn becomes dominant. An improving trend can be obtained in 1 or 2 years by proper use and deferment of grazing.

Three-awn generally is one of the first grasses to come back on range in poor condition. It is followed in later years by fall witchgrass and decreaser plants.

In the desert shrub vegetative zone, the potential plant community is about 55 percent decreasers. The major decreasers are green sprangletop, side-oats grama, tangle-head, fall witchgrass, Arizona cottontop, menodora, kidneywood, and bush sunflower. The main increasers are chino grama, slim tridens, perennial three-awn, guajillo, sotol, lechuguilla, candelilla, mimosa, hairy tridens, and annuals. Common invaders are croton, persimmon, red grama, coldenia, and creosotebush. Ocotillo is native to these soils.

The estimated potential air-dry herbage yield on range in excellent condition in the grassland vegetative zone is 800 pounds per acre during favorable years and 600 pounds per acre during unfavorable years. In the desert shrub vegetative zone, the estimated potential yield is 600 pounds per acre during favorable years and 300 pounds per acre during unfavorable years. Capability unit VIIs-1, dryland; Low Stony Hill range site.

Ector-Rock outcrop complex (Er.)—This complex is on hills and canyon walls. Slopes are moderately steep and steep.

The surface layer of Ector soils is friable, dark grayish-brown stony loam or stony clay loam about 8 inches thick. This layer is underlain by fractured hard limestone.

The Rock outcrop part, of this complex consists of areas of exposed limestone bedrock.

The moderately steep to steep slopes of Ector soils are broken by short nearly vertical exposures of limestone bedrock. Escarpments near hilltops are common.

Slopes of soils between exposures of limestone bedrock range from 10 to 35 percent. The amount of Rock outcrop in this complex ranges from 20 to 50 percent in different areas.

Included with this complex in mapping are areas and pockets of shallow and deep stony soils and areas of Sanderson and Upton soils at the bases of hills.

Surface runoff is rapid on Ector soils. Water from light rains runs off of Rock outcrop to the Ector soils and benefits plants. Much of the water from heavy rains, however, runs across Ector soils because the soils are very shallow. If these soils are not protected by a cover of plants, the hazard of water erosion is high. This complex is too steep and stony to be used as pasture or for crops and is used as range.

In the grassland vegetative zone, the potential plant community is about 60 percent decreasers. The major decreasers are side-oats grama, green sprangletop, cane bluestem, tanglehead, little bluestem, skeletonleaf goldeneye, and feather dalea. Other decreasers are bush sunflower. menodora, penstemon, and butterflybush. The main increasers are slim tridens, perennial three-awn, fall witch-grass, black grama, mimosa, and sotol. Common invaders are juniper, lechuguilla, catclaw, red grama, persimmon, and pricklypear. Juniper has spread from the rocky ravines.

Overgrazing of this complex results in a rapid decrease in little bluestem and green sprangletop. If overgrazing continues, the complex is eventually dominated by three-awn and juniper.

On range in excellent condition, the estimated potential air-dry herbage yield in the grassland vegetative zone is 600 pounds per acre during favorable years and 300 pounds per acre during unfavorable years. In the desert shrub vegetative zone, the estimated potential yield is 400 pounds per acre during favorable years and 200 pounds per acre during unfavorable years. Capability unit VIIs-1, dryland; Steep Rocky range site.

Ector-Upton association (Eu).—This association is mainly on plateaus or mesas between major canyons. It consists of about equal parts of Ector and Upton soils. Most areas are more than 80 acres in size, and the common range is from 200 to 800 acres in size. The soils are nearly level to gently undulating. Upton soils are nearly level, but Ector soils are on breaks and small hills and commonly have stronger slopes.

The Ector soils have a surface layer of friable, grayish-brown stony loam about 8 inches thick. This layer is underlain by limestone bedrock. The amount of coarse limestone and caliche fragments on the surface and in Ector soils ranges from 50 to 80 percent.

The Upton soils have a surface layer of light brownish-gray gravelly loam about 2 inches thick. The subsoil is about 10 inches of friable, light brownish-gray gravelly loam. It is underlain by whitish caliche that is indurated in the upper part and weakly cemented in the lower part. The amount of coarse fragments on the surface and in the soil mass ranges from 20 to 50 percent.

Included with this association in mapping are rounded to oblong areas of Reagan silty clay loam about 40 acres in size and small depressions containing soils that are clay or clay loam in texture and are darker in color than Ector or Upton soils. Also included are areas of Rock outcrop.

The soils of this association are well drained and moderately permeable. Available water capacity is low. A crust forms on these soils and inhibits water intake.

The potential plant community consists of 40 percent decreasers. The major decreasers are side-oats grama, cane bluestem, blue grama, bush muhly, and plains bristlegrass. The main increasers are tobosa, black grama, slim tridens, and perennial three-awn. Other increasers are broom snakeweed, sacahuista, sotol, and ephedra. Common invaders are juniper, coldenia, catclaw, mesquite, and red grama.

These soils are too shallow and stony to be used as pasture or for growing crops. They are suited to range.

The estimated potential air-dry herbage yield on range in excellent condition is 600 pounds per acre during favorable years and 300 pounds per acre during unfavorable years. Ector part, capability unit VIIs-1, dryland; Low Stony Hill range site. Upton part, capability unit VIIs-2, dryland; Gravelly range site.

Gila Series

The Gila series consists of deep, level to nearly level, loamy soils that formed in recent alluvium. These soils are on flood plains and low terraces of the Rio Grande and Pecos River. Slopes are less than 1 percent.

In a representative profile the surface layer, about 15 inches thick, is light brownish-gray loam. The underlying material, to a depth of 50 inches or more, is pale-brown, friable loam that is stratified with thin layers of fine sandy loam and silt loam.

The Gila soils are well suited to pasture and irrigated crops.

Representative profile of Gila loam (in an area of Gila soils in a field on the flood plain of the Pecos River, 300 feet east of a reservoir that is 1 mile north of Wilson Banner Ranch headquarters and about 32 miles northeast of Dryden):

A1—0 to 15 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak, fine, sub-angular blocky structure; slightly hard, friable; a few earthworm casts; calcareous; moderately alkaline; clear, smooth boundary.

C—15 to 50 inches +, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; massive; slightly hard, friable; stratified with thin layers of fine sandy loam and silt loam; calcareous; moderately alkaline.

The A horizon ranges from about 8 to 20 inches in thickness and light brownish gray to pale brown in color. Texture ranges from loam to silt loam or fine sandy loam. The C horizon is very pale brown to light brownish-gray loam, silt loam, and fine sandy loam. This horizon is stratified.

Gila soils (Ga).—These are the only Gila soils mapped in the county. They are level to nearly level and are on flood plains and low terraces of rivers. Most areas are long and narrow, and they parallel the rivers. Slopes are less than 1 percent. The surface layer ranges from loam to silt loam or fine sandy loam.

Included in mapping are small areas of stream-washed gravelly material and sandy soils next to river channels. Also included are Glendale soils in small depressions.

Gila soils are well drained and moderately permeable. Available water capacity is high. Runoff is slow. In areas unprotected by plant cover, the soils form a crust, and in these areas runoff of water and hazard of erosion are increased.

Gila soils in areas that are not irrigated generally are unsuited to crops because of low rainfall. Areas that receive additional water by drainage or by water spreading are suitable as pasture. Pasture or hay crops can be established and maintained successfully if management is good.

Irrigated Gila soils are well suited to a variety of crops and have few limitations that restrict their use (fig. 11). Because of their location these soils require protection from floodwaters. The soils are naturally low in humus. The cropping system should include crops that produce a large amount of residue and help to improve the quality of the soil. After crops are harvested, residue should be left on or near the surface. This will help to reduce the amount of surface crusting and deterioration of soil structure, and it will help to keep the soil in good tilth.

Figure 11.—Alfalfa on Gila soils irrigated by sprinklers.

The potential plant community on these soils is 55 to 65 percent decreasers. The major decreasers are cane bluestem, side-oats grama, Arizona cottontop, vine-mesquite, and plains bristlegrass. The increasers are mostly sand dropseed, alkali sacaton, four-wing saltbush, and buffalograss. Common invaders are mesquite, catclaw, prickly-pear, and annuals. Saltcedar generally grows along stream channels.

Overgrazing of these soils results in an increase in mesquite and other brush. Severe erosion in gullies is a concern.

The estimated potential air-dry herbage yield on range in excellent condition is 2,000 pounds per acre during favorable years and 1,000 pounds per acre during unfavorable years. Yield of johnsongrass used for dryland pasture is about 1.7 tons per acre during favorable years. Capability unit VIc-1, dryland, and I-1, irrigated; Overflow range site.

Glendale Series

The Glendale series consists of deep, level to nearly level, loamy soils. These soils formed in recent mixed alluvium. They are on flood plains and low terraces of streams. Slopes are less than 1 percent.

In a representative profile the surface layer is light brownish-gray clay loam about 14 inches thick. The underlying material, to a depth of about 60 inches, is very pale brown, friable clay loam that is stratified with thin layers of loam, silty clay loam, and sandy loam.

Representative profile of Glendale clay loam (in an area of Glendale soils, in a draw 100 feet west and 1 1/4 miles north of the fork in the county road leading to the John Montgomery Ranch, about 8 miles north of Pumpville):

A1—0 to 14 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

C—14 to 60 inches +, very pale brown (10YR 7/3) clay loam, brown (10YR 4/3) moist; structureless (massive); slightly hard, friable; stratified with thin layers of loam, silty clay loam, and sandy loam; a few fine specks of lime; calcareous; moderately alkaline.

The A horizon ranges from light brownish gray to pale brown in color and is loam or clay loam in texture. The C horizon ranges from pale brown to very pale brown in color. Texture ranges from loam to clay loam.

Glendale soils (Ge).—These level to nearly level soils are on flood plains and low terraces of streams. They generally are in long narrow areas enclosing draws and streams. The surface layer is loam or clay loam.

Included in mapping are areas of unclassified gravelly and stony stream-washed materials that are of little value as range.

Glendale soils are well drained and moderately slowly permeable. Available water capacity is high. Runoff is slow. In areas unprotected by plant cover, the soils form a crust, and runoff and soil erosion are increased.

Glendale soils in areas that are not irrigated generally are unsuited to crops because of low rainfall. Areas that receive additional water by drainage or by water spreading are suited to use as pasture. Pasture or hay crops can be established and maintained successfully if management is good.

Irrigated Glendale soils are well suited to a variety of crops and have few limitations that restrict their use. Because of their location, these soils require protection from floodwaters. These soils are low in humus. The cropping system should include crops that produce a large amount of residue and help to improve the quality of the soil. After crops are harvested, residue should be left on or near the surface. The residue will help to reduce the amount of surface crusting and deterioration of soil structure, and it will help to keep the soil in good tilth.

The potential plant community on these soils is 60 percent decreasers. The major decreasers are cane bluestem, side-oats grama, vine-mesquite, blue grama, and butterfly-bush. The increasers are buffalograss, tobosa, four-wing saltbush, fall witchgrass, and wolfberry. Common invaders are mesquite, tarbush, creosotebush, tasajillo, burrograss, and annual plants.

The estimated potential air-dry herbage yield on range in excellent condition is about 300 pounds per acre during favorable years and 800 pounds per acre during unfavorable years. Yield of johnsongrass used for pasture is about 1.7 tons per acre during favorable years. Capability unit VIc-1, dryland and I-1, irrigated; Overflow range site.

Lozier Series

The Lozier series consists of nearly level to steep soils that are very shallow over limestone. These soils are on mesas and hillsides.

In a representative profile the surface layer is light brownish-gray gravelly loam that is about 40 percent limestone fragments. It is about 8 inches thick. Below this layer is fractured limestone bedrock.

Lozier soils are unsuitable for crops or pasture and are used as native range.

Representative profile of Lozier gravelly loam, about 1 percent slope (in an area of Lozier soils in a pasture 1 mile north of the H.E. Gatlin Ranch headquarters, 17 miles southwest of Sanderson):

A1—0 to 8 inches, light brownish-gray (10YR 6/2) gravelly loam, brown (10YR 5/3) moist; weak, platy in the upper 2 inches and weak, subangular blocky structure below; soft, friable; 40 percent, by volume, of lime-coated, thin, flat limestone fragments, mostly angular, $^1/_2$ inch to 3 inches in diameter; calcareous; moderately alkaline; abrupt, wavy boundary.

Rca—8 to 15 inches +, fractured limestone bedrock interbedded with loamy soil; caliche coatings on surface and in fractures.

The A horizon ranges from very pale brown to light brownish gray in color. Volume of coarse fragments ranges from 35 to 80 percent, generally increasing with depth. Depth to the R horizon ranges from 3 to 13 inches. Caliche coatings in fragments vary from faint films to films 1 inch in thickness. The caliche coatings on the limestone bedrock range from $^1/_2$ inch to 3 inches in thickness.

Lozier soils (Lo).—Lozier soils are nearly level to sloping, and they occur on mesas and limestone hills. Slopes rang from 0 to 8 percent.

These soils have the profile described as representative of the Lozier series (fig. 12). The surface layer is loam and has 50 to 80 percent limestone fragments that range from pebbles to stones.

Figure 12.—Profile of Lozier gravelly loam.

Included in mapping are areas of Sanderson and Glendale soils in narrow drainageways.

Lozier soils are well drained and are moderately permeable. The available water capacity is low. The soils are too shallow and stony to be used as pasture or for crops and are used as range (fig. 13).

The potential plant community is approximately 55 percent decreasers. The major decreasers are chino grama, bush muhly, and skeleton leaf goldeneye. The

Figure 13.—Area of Lozier soils.

main increasers are slim tridens, perennial three-awn, range ratany, guayacan, feather dalea, Halls panicum, and annual forbs. Common invaders are creosotebush, red grama, tasajillo, coldenia, croton, and cenizo.

The estimated potential air-dry herbage yield on range in excellent condition is about 350 pounds per acre during favorable years and 150 pounds per acre during unfavorable years. Capability unit VIIs-2, dryland; Shallow Ridge range site.

Lozier-Upton association (Lu).—This association is on hills and on fans at the base of hills.

The Lozier soil makes up 70 to 90 percent of the association; about 50 percent of the acreage has 0 to 5 percent slopes and about 50 percent has 5 to 45 percent slopes. The Upton soil makes up to 10 to 30 percent of the association and has 0 to 5 percent slopes.

The Lozier soil has a surface layer of light brownish-gray loam that contains many limestone fragments and is about 8 inches thick. The underlying material is fractured limestone bedrock. Lozier soil is on hills.

The Upton soil has a surface layer of light brownish-gray gravelly loam about 2 inches thick. The next layer, about 10 inches thick is friable, light brownish-gray

gravelly loam. The underlying material is whitish caliche that is indurated in the upper part becoming weakly cemented below. Upton soils are on fans at the base of hills.

Included with this association in mapping are small areas of Glendale soils in depressions and drainageways.

The soils of this association are well drained and moderately permeable. The available water capacity is low. The flat shingled stones and steep slopes of the Lozier soil cause runoff, especially during high intensity rains. These soils support a thin cover of vegetation. The soils are too steep and shallow to be used as pasture or for crops and are used as range.

The potential plant community is approximately 20 percent decreasers. The major decreasers are chino grama, tanglehead, skeletonleaf goldeneye, and menodora. The main increasers are cenizo, Halls panicum, broom snake-weed, lechuguilla, catclaw, range ratany, annuals, perennial three-awn, and sotol. Common invaders are creosote-bush and mesquite (fig. 14).

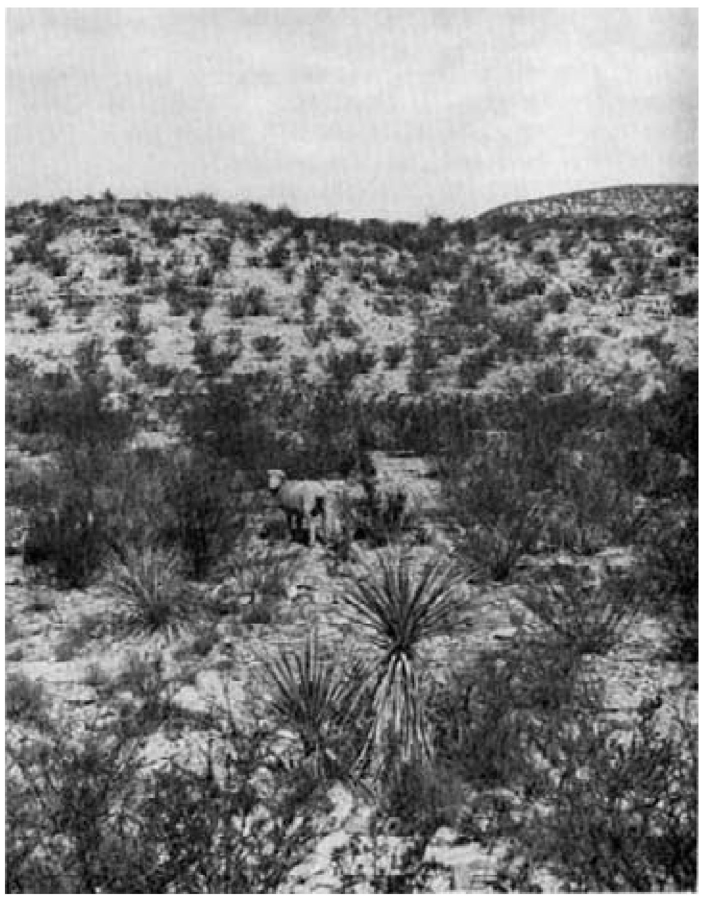


Figure 14.—Creosotebush and china grama are dominant plants on soils of Lozier-Upton association.

Heavy continuous grazing results in almost barren soil. If the soil is depleted of vegetation, recovery is very slow.

The estimated potential air-dry herbage yield on range in excellent condition is about 300 pounds per acre during favorable years and 150 pounds per acre during unfavorable years. Both soils in capability unit VIIs-2, dryland; Lozier part in Flagstone Hill range site; Upton part, Gravelly range site.

Reagan Series

The Reagan series consists of deep, nearly level to gently sloping, loamy soils in upland valleys and on plains. These soils formed in loamy sediment washed mostly from limestone uplands.

In a representative profile the surface layer is silty clay loam about 10 inches thick. It is light brownish gray in the upper 3 inches and brown in the lower 7 inches. The next layer, about 22 inches thick, is friable, light-brown silty clay loam. The underlying material, to a depth of 70 inches, is pink clay loam. The upper part contains 20 percent, by volume, of concretions and powdery bodies of calcium carbonate. The percent of calcium carbonate decreases with increasing depth (fig. 15).

Figure 15.—Profile of Reagan silty loam.

These soils are well suited to pasture and irrigated crops. The main use is native range.

Representative profile of Reagan silty clay loam (in pasture on the north property line of the Hicks Ranch, 0.5 mile west of county road):

A11—0 to 3 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, thin, platy structure; soft, friable; common fine roots; calcareous; clear, smooth boundary.

A12—3 to 10 inches, brown (10 YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate, fine, subangular blocky structure; slightly hard, friable; common fine roots; common earthworm casts and insect burrows calcareous; moderately alkaline; gradual, smooth boundary.

B2—10 to 32 inches, light-brown (7.5YR 6/4) silty clay loam, brown (7.5YR 4/4) moist; moderate, fine, subangular blocky structure; slightly hard, friable; few fine roots; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—32 to 50 inches, pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) moist; about 20 percent, by volume, weakly cemented concretions and powdery bodies of segregated calcium carbonate: about 5 percent, by volume, limestone pebbles, mostly less than a half inch in diameter; calcareous; moderately alkaline; gradual, wavy boundary.

C2—50 to 70 inches +, pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) moist; a few segregates of calcium carbonate and about 5 percent, by volume limestone pebbles; calcareous; moderately alkaline.

The A horizon ranges from light brownish gray to brown in color and from 6 to 12 inches in thickness. The B2 horizon ranges from light brown to brown in color and from 16 to 28 inches in thickness.

The C1ca horizon is at depths ranging from 20 to 40 inches and is from 10 to 30 inches in thickness. In some profiles the C1ca horizon is weakly cemented caliche that contains few to many imbedded limestone pebbles. The underlying C2 horizon ranges from clay loam to gravelly loam.

In some profiles the content of gravel ranges up to 15 percent by volume, throughout the profile. The calcium carbonate equivalent ranges from 10 to 35 percent, by volume, in the upper 40 inches of the profile.

Reagan silty clay loam (Re).—This is the only Reagan soil mapped in the county. It is a nearly level to gently sloping soil in upland valleys and on plains. Most areas of this soil are 40 to 600 acres in size. The areas are oval shaped, and most slopes are between 0.4 and 1.5 percent.

Included in mapping are areas of Sanderson and Upton soils that are on slightly higher positions adjacent to steeper slopes. Also included are areas of Dev and Glendale soils along small drainageways.

Reagan soils are well drained and moderately permeable. Available water capacity is high. Runoff is moderate to slow. If the soils form a crust, runoff and the hazard of erosion are increased.

Reagan soils generally are unsuited to crops because of low rainfall. Areas that receive additional water from run-off or by water spreading are suited to pasture (fig. 16). Pasture or hay crops can be established and maintained successfully if management is good.

Irrigated Reagan soils are well suited to a variety of crops and have few limitations that restrict their use. The cropping system should include crops that produce a large amount of residue and help to improve the quality of the soil. After crops are harvested, residue should be left on or near the surface. This will help to reduce the amount of deterioration of soil structure and help to keep the soil in good tilth.

Figure 16.—Area of Reagan silty clay loam rootplowed and seeded to johnsongrass.

In the grassland vegetative zone, the potential plant community is open grassland consisting of 55 to 65 percent decreasers. The major decreasers are side-oats grama, blue grama, cane bluestem, vine-mesquite, Arizona cottontop, and bush muhly. The increasers are mainly tobosa, slim tridens, perennial three-awn, buffalograss, and burrograss. Common invaders of this site are mesquite, tarbush fluff-grass, red grama, and animals. Overgrazing results in an increase of burrograss and invasion by mesquite and tarbush. If overgrazing continues, mesquite and tarbush become dominant, water erosion and runoff become severe, and brush control and reseeding are needed for recovery of the range.

In the desert shrub vegetative zone, the potential plant community is 50 percent decreasers. The major decreasers are Arizona cottontop, side-oats grama, cane bluestem, tobosa, and plains bristlegrass. The main increasers are slim tridens, burrograss, perennial three-awn, four-wing saltbush, and tarbush. Common invaders are mesquite, creosotebush, ear muhly, fluffgrass, three-awn, and coldenia. Overgrazing results in an increase in creosotebush and mesquite.

In the grassland vegetative zone, the estimated potential air-dry herbage yield on range in excellent condition is about 1,000 pounds per acre during favorable years and 400 pounds per acre during unfavorable years. In the desert shrub vegetative zone, estimated potential air-dry herbage yield on range in excellent condition is about 600 pounds per acre during favorable years and 200 pounds per acre during unfavorable years. Yield of johnsongrass used for pasture is about 2 tons per acre. Capability unit VIc-1, dryland, and I-1, irrigated; Deep Soil range site.

Sanderson Series

The Sanderson series consists of deep, nearly level to gently sloping gravelly loams that are several feet thick. These soils formed in gravelly outwash materials from limestone hills. They are on the foot slopes and alluvial fans below limestone hills.

In a representative profile the surface layer is light brownish-gray gravelly loam about 2 inches thick. The next layer is very friable, light brownish-gray gravelly loam about 7 inches thick. The next lower layer, about 19 inches thick, is very friable, light brownish-gray gravelly loam that contains about 1 percent of calcium carbonate films

and threads. Below this is very friable, very pale brown gravelly loam that extends to a depth of 60 inches.

These soils are used mainly as native range, but small areas are used as pasture and for irrigated crops.

Representative profile of Sanderson gravelly loam (in an area of Sanderson-Upton association, on a slope of about 3 percent, in pasture 200 feet east of U.S. Highway 285 and 1 mile north of its junction with U.S. Highway 90 at Sanderson) :

A1—0 to 2 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, thin, platy structure; slightly hard, very friable; 30 percent, by volume, angular limestone fragments that are $^1/_8$ inch to 1 inch in diameter; calcareous; moderately alkaline; clear, smooth boundary.

B2—2 to 9 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky and granular structure; slightly hard, very friable; 30 percent, by volume, angular limestone fragments that are $^1/_4$ inch to 2 inches in diameter; less than 1 percent of mass is films and threads of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

C1ca—9 to 28 inches, light brownish-gray (10YR 6/2) gravelly loam, brown (10YR 4/3) moist; weak, fine, subangular blocky structure; slightly hard, very friable; 40 percent, by volume, limestone fragments that are $^1/_4$ to 2 inches across; a few are up to 3 inches; about 1 percent of mass is films and threads of calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

C2—28 to 60 inches +, very pale brown (10YR 7/3) gravelly loam, brown (10YR 5/3) moist; structureless; slightly hard, very friable; 40 percent, by volume, angular limestone fragments; calcareous; moderately alkaline.

The A horizon ranges from light, brownish gray to very pale brown in color and front 0 to 3 inches in thickness. Texture in all horizons ranges from a loam to clay loam. The volume of coarse fragments in all horizons ranges from 35 to 50 percent.

The C horizon ranges from light brownish gray to very pale brown in color. Threads, films, and soft masses of visible segregated calcium carbonate in the C1ca horizon range from almost none to 5 percent.

Sanderson-Upton association (Su).—This association consists of 50 to 80 percent Sanderson soils and 20 to 50 percent Upton soils. The soils are nearly level to gently sloping. The Upton soils are mostly around the edge in a transitional area between the Sanderson soils and the Ector soils, but they also occur as ridges in broad areas of Sanderson soils.

The Sanderson soils have the profile described as representative for the series, but all layers of the profile range from loam to clay loam.

The Upton soils have a surface layer of light brownish-gray gravelly loam about 2 inches thick. The next layer is friable, light brownish-gray gravelly loam about 10 inches thick. The underlying material is broken and indurated whitish caliche in the upper part and weakly cemented below.

The soils of this association are well drained and moderately permeable. Surface runoff is medium. Available water capacity is low.

These soils are used plainly as range. Areas that receive additional water by drainage or by water spreading are suited to pasture. Pasture or hay crops can be established and maintained successfully if management is good.

The Sanderson soils of this association are suitable for irrigation but have limitations that restrict their use. The gravelly condition of the soils makes the use of mechanical tools difficult.

The potential plant community is of 55 to 65 percent decreasers. The major decreasers are side-oats grama, cane bluestem, bush muhly, plains bristlegrass, menodora, and feather dalea. The main increasers are black grama, slim tridens, perennial three-awn, and such plants as range ratany sacahuista, catclaw, and sotol. Common invaders are creosotebush, mesquite, juniper, coldenia, red grama, and annuals (fig. 17).

Figure 17.—Area of Sanderson-Upton association in fair range condition. Dominant grasses are side-oats grama and perennial three-awns.

Overgrazing of this association results in an increase in creosotebush. If overgrazing continues, the association is eventually dominated by creosotebush.

The estimated potential air-dry herbage yield on range in excellent condition is about 400 pounds per acre during favorable years and 200 pounds per acre during unfavorable years. Sanderson part, capability unit VIs-2, dry-land, and IIIs-1, irrigated; Gravelly range site. Upton part, capability unit VIIs-2 dryland; Gravelly range site.

Upton Series

The Upton series consists of shallow, nearly level to hilly, gravelly soils on uplands. These soils formed in gravelly alluvial sediment. They are on divides of hills and on alluvial fans and foot slopes below hills.

In a representative profile the surface layer is light brownish-gray gravelly loam about 2 inches thick. The next layer, about 10 inches thick is friable, light brownish-gray gravelly loam. The underlying material, to a depth of 50 inches, is whitish caliche that is broken and indurated in the upper part and becomes weakly cemented in the lower part.

Upton soils are poorly suited to crops and are mainly used as range.

Representative profile of Upton gravelly loam (in an area of Upton very gravelly soils having a slope of about 3 percent, in pasture 300 feet north of U.S. Highway 90 and 1.5 miles west of its junction with U.S. Highway 285 at Sanderson):

A1—0 to 2 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; compound, weak, thin, platy and weak, fine, subangular blocky structure; slightly hard, friable; 25 percent, by volume, strongly cemented caliche fragments, mostly less than 1 inch in diameter; calcareous; moderately alkaline; abrupt, smooth boundary.

B2—2 to 12 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure; slightly hard, friable; 35 percent, by volume, caliche fragments, mostly $^1/_8$ inch to 1 inch in diameter; few insect burrows; few films of lime; calcareous; moderately alkaline abrupt, wavy boundary.

C1cam—12 to 38 inches, whitish caliche in broken layers 1 inch to 3 inches thick, upper $^1/_4$ to 1 inch is indurated and laminar; cementation becomes less with depth; embedded pebbles are 5 percent, by volume.

C2—38 to 50 inches +, whitish, weakly cemented caliche containing pebbles and cobblestones.

The A horizon ranges from grayish brown to pale brown in color and is 0 to 6 inches in thickness. The B2 horizon ranges from light brownish gray to very pale brown or light brown in color and from 6 to 14 inches in thickness. Depth to the C1cam horizon ranges from 6 to 20 inches.

Texture ranges from loam to clay loam, and percentage of coarse fragments ranges from 20 to 35 percent. Thickness of strongly cemented or indurated caliche ranges from 2 to 36 inches but is mainly 4 to 13 inches. It is underlain by weakly cemented or uncemented gravelly and stony materials or lime-stone bedrock.

Upton very gravelly soils (Up).—These gently sloping to hilly soils are on uplands. They formed from outwash materials of mixed sources. The soil material contains a variety of gravel and stones washed from areas containing limestone, chert, and igneous materials. Most areas range from 40 to 600 acres in size.

These soils have the profile described as representative for the series.

Included in mapping are areas of Ector and Lozier soils, which are on slightly higher positions. Also included are areas of soils similar to Upton that are more than 50 percent gravel.

Upton very gravelly soils are moderately permeable. Available water capacity is low. The surface cover of gravel and stones reduces soil erosion. These soils are used mainly for grazing and are unsuitable for cultivation because of shallowness and the high content of gravel.

The potential plant community is approximately 60 percent decreasers. The major decreasers are chino grama, bush muhly, black grama, tanglehead, bush sunflower, and menodora. The main increasers are slim tridens, perennial three-awn, hairy grama, mimosa, skeletonleaf golden-eye, and other plants such as sotol, lechuguilla, and ocotillo (fig. 18). Invaders are coldenia, fluffgrass, red grama, and creosotebush.

The estimated potential air-dry herbage yield on range in excellent condition is about 700 pounds per acre during favorable years and 400 pounds per acre during unfavorable years. Capability unit VIIs-2, dryland; Gravelly Hill range site.

Upton soils (Ut).—These nearly level to gently sloping gravelly loam soils are on divides between hillsides and on fans or foot slopes below the hillsides. Slopes are from 0 to 5 percent. Most areas are 100 to 1,000 acres in size.

The surface layer is light brownish-gray gravelly loam about 2 inches thick. The next layer is friable, light brownish-gray gravelly loam about 2 inches thick. The underlying material is broken and indurated whitish caliche in the upper part and becomes weakly cemented below (fig. 19).

Figure 18.—Area of Upton very gravelly soils in good range condition.

Figure 19.—Profile of Upton gravelly loam.

Included in mapping are areas of Lozier soils less than 40 acres in size. These soils are on higher knobs or breaks. Also included are areas of Glendale soils in small depressions and drainageways.

Upton soils are well drained and moderately permeable. Available water capacity is low.

They are not suitable for pasture or crops and are used as range.

The potential plant community is about 50 percent decreasers, such as chino grama, black grama, bush muhly, and skeletonleaf goldeneye.

Plants that increase in overgrazed areas are burrograss, slim tridens, range ratany, and annual and perennial forbs such as bladderpod. Creosotebush has increased and is dominant on most areas of the soils.

The estimated potential air-dry herbage yield on range in excellent condition is about 250 pounds per acre during favorable years and 100 pounds per acre during unfavorable years. Capability unit VIIs-2, dryland; Gravelly range site.

Upton-Reagan-Lozier association (Uz).—This association consists of Upton, Reagan, and Lozier soils that are too intermingled to be used or managed separately. The association is made up of 30 to 50 percent Upton soils, 30 to 40 percent Reagan silty clay loam, and 10 to 30 percent Lozier soils (fig. 20). These soils are on low-lying hills or ridges, on foot slopes that extend out from these hills and ridges, and in drainageways and depressions. Lozier soils are on the hills and ridges, Upton soils are on the foot slopes, and Reagan soils occupy drainageways and depressions. Slopes range from 0 to 12 percent. Most areas are more than 5 acres in size and generally range from 20 to 80 acres, but a few areas range to 160 acres.

Figure 20.—Area of Upton-Reagan-Lozier association; Upton soils are on the foot slopes, Reagan soils in the drainageways, and Lozier soils on the hills.

The Upton soils have a surface layer of light brownish-gray gravelly clay loam about 2 inches thick. The next layer is friable, light brownish-gray loam or gravelly clay loam about 10 inches thick. The underlying material is broken and indurated whitish caliche in the upper part and becomes weakly cemented in the lower part.

The Reagan soils have a surface layer of light brownish-gray silty clay loam about 3 inches thick. The next layer is friable, brown silty clay loam about 5 inches thick. The next layer is friable, light-brown silty clay loam about 20 inches thick. The underlying material is pink clay loam that contains, by volume, about 20 percent concretions and powdery bodies of calcium carbonate. The percent of calcium carbonate decreases with increasing depth.

The Lozier soils have a surface layer of pale-brown loam that contains about 20 percent limestone fragments and is about 2 inches thick. The next layer is friable, very pale brown loam that contains about 50 percent limestone fragments and is about 6 inches thick. The underlying material is fractured limestone bedrock.

Included in mapping with this association are areas of Sanderson and Ector soils.

This association is used as pasture and range. Vegetation consists of a moderate cover of tarbush, creosotebush, and acacia, and grasses such as chino grama, three-awn, and tridens. Upton part, capability unit VIIs-2, dryland; Gravelly range site. Reagan part, capability unit VIc-1, dryland; Deep Soil range site. Lozier part, capability unit dryland; Shallow Ridge range site.

Use and Management of the Soils

This section briefly explains the system of capability classification used by the Soil Conservation Service and discusses the use of the soils as range. Then uses of the soils for wildlife and for engineering purposes are dismissed. Those who wish to know the capability classification or the range site of a given soil can refer to the "Guide to Mapping Units" at the back of this survey. Those who want detailed information about the management of the soil for crops or range can refer to the section "Descriptions of the Soils."

Capability Grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on limitations of soils when used for field crops, the risk of damage when they are fanned, and the way the soils respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The placement of any mapping unit in the grouping can be learned by turning to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c*, to the class numeral, for example, IIs. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained: *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* shows that the chief limitation is climate that is too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w,s,* and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIs-1 or VIc-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Following is a descriptive outline of the system as it applies to Terrell County.

Class I. Soils that have few limitations that restrict their use.
- Unit I-1 (irrigated). Deep, well-drained, loamy soils.

Class II. Soils that have some limitations that reduce the choice of plants or that require moderate conservation practices.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Unit IIs-1 (irrigated). Deep, very slowly permeable, clayey soils.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
  - Unit IIIs-1 (irrigated). Deep, nearly level to gently sloping, gravelly loam soils.

Class IV. Soils that have very severe limitations that reduce the choice of plants, require very careful management, or both. (None of the soils in Terrell County have been placed in Class IV.)

Class V. Soils that are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.
- Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.
  - Unit Vw-1 (irrigated). Deep, very gravelly, occasionally flooded, loamy soils.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or food and cover for wildlife.
- Subclass VIw. Soils severely limited by excess water, generally unsuitable for cultivation.
  - Unit VIw-1 (dryland). Deep, very gravelly, occasionally flooded, loamy soils.
- Subclass VIs. Soils that are generally unsuitable for cultivation and are limited for other uses by low moisture capacity, stones, or other soil features.
  - Unit VIs-1 (dryland). Deep, very slowly permeable, clayey soils.
  - Unit VIs-2 (dryland). Deep, nearly level to gently sloping, gravelly loam soils.
- Subclass VIc. Soils that have severe limitations because of climate.
  - Unit VIc-1 (dryland). Deep, well-drained, loamy soils.

Class VII. Soils that have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.
- Unit VIIs-1 (dryland). Very shallow, nearly level to steep, gravelly and stony soils.
- Unit VIIs-2 (dryland). Shallow and very shallow, nearly level to steep, gravelly soils.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.
- Subclass VIIIs. Soil materials that have little potential for production of plants.
  - Unit VIIIs-1 (dryland). Gently sloping to moderately steep, clayey material.

Range Sites and Condition Classes

Rangeland is classified into range sites according to its capacity to produce native vegetation. Different kinds of range produce different kinds and amounts of vegetation. The inherent productive capacity of different areas of rangeland depends principally on the combined effects of the soils and the climate. Each range site has its own soils and environmental conditions, and these produce a characteristic plant community.

The plant community that uses the site fully and that successfully maintains and reproduces itself is called the potential, or the climax, for the site. Generally this mixture of plants grows on a site so long as the site is not over-grazed and the environment remains unchanged. Native plants are referred to as decreasers, increasers, and invaders. Decreasers and increasers are a part of the climax vegetation.

Livestock graze selectively and seek the plants that are most palatable. Decreasers are steadily reduced or killed by heavy, continuous grazing. Increasers become more abundant when the decreasers begin to decline. Increasers are commonly shorter and less palatable than the decreasers. If the increasers are grazed heavily, they decline and are replaced by invaders. Invaders are plants normally not present in the original plant community. Many are plants not suitable for grazing, such as brush, and others are less palatable, low-growing grasses and weeds. Many are spiny and poisonous.

Range condition is determined by comparing the kinds and numbers of plants that make up the vegetative cover with those in the potential native plant cover for the same site. Range condition indicates the degree to which the composition of the existing plant community differs from the potential, or the climax, vegetation. Four classes are recognized. A range is in *excellent condition* if 76 to 100 percent of the vegetation is the same kind as that in the original stand; it is in *good condition* if the percentage is between 51 and 75, in *fair condition* if the percentage is between 26 and 50; and in *poor condition* if the percentage is 25 or less.

A range site in excellent condition is at or near its maximum productivity. A site in good condition has lost a few decreaser plants, but it is still productive and can be maintained and improved by good management of grazing. A site in fair condition has a severely altered plant community in which increasers dominate and invaders are becoming prominent. A site in poor condition has lost almost all of the desirable forage plants, has few plants that are part of the original vegetation, and has many invaders.

Good range management requires recognition of the range site and determination of range condition. Range that is kept in good or excellent condition provides optimum forage yields and is protected against excessive erosion and loss of water.

For most range sites and most range livestock operations, the higher the range condition class, the greater is the quality and amount of available forage.

Ten range sites are recognized in Terrell County:

Bottomland Site

This range site consists of deep, gravelly, loamy soils that are flooded occasionally.

Clay Flat Site

This range site consists of deep, nearly level, clayey soils that are slowly permeable.

Deep Soil Site

This range site consists of deep, nearly level to gently sloping, loamy soils that are well drained.

Flagstone Hill Site

This range site consists of very shallow, nearly level to steep, flaggy loams.

Gravelly Site

This range site consists of shallow, nearly level to hilly, gravelly loams.

Gravelly Hill Site

This range site consists of shallow, gently sloping to hilly, gravelly loams.

Low Stony Hill Site

This range site consists of very shallow, nearly level to hilly, gravelly and stony loams and clay loams.

Overflow Site

This range site consists of deep, nearly level, well-drained loamy soils that are on flood plains and terraces.

Shallow Ridge Site

This range site consists of very shallow, nearly level to sloping, gravelly loams.

Steep Rocky Site

This range site consists of very shallow, moderately steep to steep, stony loams and clay loams that have many rock outcrops.

The "Guide to Mapping Units" at the back of this publication lists the range sites in which a given unit has been placed. In the section "Descriptions of the Soils," the range sites are listed at the end of the individual mapping unit description. In the description, the vegetation is described, and the estimated potential air-dry herbage yield on range in excellent condition is given for both favorable and unfavorable years. Some of the mapping units occur in both the grassland and the desert shrub vegetative zones. For the general line of separation of these zones, see figure 23.

Wildlife

The soil associations of Terrell County have been as-signed to two wildlife sites. Each site is different in topography, kind and amount of vegetation, production, and to some extent, in the principal kinds of wildlife that inhabit it. The soil associations are described in the section "General Soil Map."

Assistance in managing soils as habitat for wildlife can be obtained from the Soil Conservation Service in the Rio Grande-Pecos River and Trans-Pecos Soil and Water Conservation Districts, from the Texas Agricultural Extension Service, and from the Texas Parks and Wildlife Department.

Wildlife site 1

This site is made up of the Ector-Rock outcrop, Ector-Lozier, Upton-Lozier-Reagan, and Lozier-Upton soil associations. It consists of very shallow to deep, nearly level to steep, flaggy and stony, loamy soils.

Soils on this site support mixed stands of woody plants and grasses. Some of the woody plants are lechuguilla, catclaw, persimmon, and pricklypear. Some of the

grasses are fall witchgrass, black grama, Halls panicum, chino grama, bush muhly, and perennial three-awn.

The site provides habitat for many kinds of wildlife. Some of the more important are deer, javelina, dove, quail, rabbits, and turkeys. Deer are primarily browsers. They prefer leaves of brush and forbs and small amounts of grass. Javelina prefer to eat pricklypear, mesquite leaves, and lechuguilla. Dove and quail eat seeds of grasses and weeds. Rabbits prefer seeds and young green vegetation.

Watering facilities are limited mostly to livestock watering areas.

Wildlife site 2

The Sanderson-Reagan soil association is the only soil association in this site. It consists of deep, nearly level to gently sloping, gravelly, loamy soils.

Soils on this site support a mixed stand of woody plants and grasses. Some of the woody plants are mesquite, creosotebush, and juniper. Grasses are mainly Arizona cotton-top, side-oats grama, cane bluestem, tobosa, and plains bristlegrass. Food and cover can be provided in some areas by planting grasses and seed-producing plants (fig. 21).

Figure 21.—Strips of johnsongrass on Reagan silty clay loam provide excellent food and cover for wildlife.

Cover is sparse in many areas. These soils provide good habitat for deer, dove, quail, and javelina. Deer graze on leaves of brush and forbs and eat small amounts of grass. Dove and quail find nesting areas and food where vegetative cover is good. Javelina prefer the rough, rocky and stony hills.

Watering facilities are limited mostly to livestock watering areas.

Engineering Uses of the Soils

By Joe B. Came and Nelton O. Salch, agricultural engineers, Soil Conservation Service.

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the properties of soils most important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, particle size, plasticity, and soil reaction. Also important are slope, depth to the water table, and

depth to bedrock. These properties in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and of construction equipment.
7. Develop other preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 2 and 3, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering rises. This information, along with the soil maps and other parts of this publication can be used to make interpretations in addition to those given in the tables. It also can he used to make other useful maps.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Estimates generally are made to a depth of about 6 feet, and interpretations do not apply to greater depths. Also, engineers should not apply specific values to the estimates for bearing capacity and traffic-supporting capacity given in this survey. Investigation of each site is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities limitations for soil engineering. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some of the terms used in this soil survey have special meaning to soil scientists. The terms may not be known to all engineers. Many of the terms commonly used in soil science are defined in the Glossary.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system *(12)* used by the SCS engineers, Department of Defense, and others, and the AASHO system *(2)* adopted by the American Association of State Highway Officials.

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, SM-SC.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size

distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2--5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. Sand, silt, clay, and some of the other terms used in the USDA textural classification are defined in the Glossary.

Table 2 shows the estimated classification of all the soils in the county according to all three systems of classification.

Estimated engineering properties

Estimates of soil properties that are significant in engineering are listed in table 2. Estimates are based on experience with the soils of the county and in engineering construction and similar soil series in nearby counties.

Soils are laced in one of four hydrologic groups on the basis of intake of water at the end of a long duration storm, after prior wetting and swelling, and without the protection of vegetation. A description of the soils in these four groups follows:

Group A.—Soils that have high infiltration rates even when thoroughly wet. They are mainly deep, well drained to excessively drained sands and gravel. These soils have a high rate of water transmission and a low runoff.

Group B.—Soils that have moderate infiltration rates when thoroughly wet. They are mainly moderately deep to deep, moderately well drained to well drained soils that have moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

Group C.—Soils that have slow infiltration rates when thoroughly wet. They are mainly soils that have a layer that impedes the downward movement of water, or soils that have moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission.

Group D.—Soils that have very slow infiltration rates when thoroughly wet. They are mainly clay soils that have a high swelling potential, soils with a high permanent water table, soils that have a claypan or a clay layer at or near the surface, and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission and a high runoff.

Depth to bedrock indicates, in inches, the depth from the surface where consolidated materials may be found.

The percentage passing sieve estimates are given for a range in percentage of soil materials passing four different sieve sizes. This information is useful in determining the suitability of the soil as a source of material for construction purposes.

Permeability is the estimated rate in inches per hour that water moves downward through the soil. The estimates are for each soil as it occurs in place without compaction.

The available water capacity is the capacity of soils to hold water available for use by most plants. It is the difference between the amount of soil water at field capacity and the amount at wilting point and is commonly expressed as inches of water per inch of soil.

The shrink-swell potential indicates a change in volume that occurs in a soil with changes in moisture content. A knowledge of this potential is important in planning the use of a soil for building roads and other engineering structures. Shrink-swell potential is rated *low, moderate, high,* and *very high.* In general, deep clayey soils,

such as Dalby clay, have a high shrink-swell potential. Those soils with a small amount of clay or nonplastic materials have a low shrink-swell potential.

Reaction is the degree of acidity or alkalinity of a soil expressed in pH value. All the soils in Terrell County are alkaline and have a pH range of 7.9 to 8.4. For this reason, a column for reaction was not included in the table.

Engineering interpretations

Table 3 gives the suitability of soil material for certain uses and describes specific characteristics of each soil series that affect the design and application of construction measures. Some of the hazards and problems related to construction and maintenance are given in the table.

Ratings are given for the suitability of soil material for topsoil. Soils are rated poor or fair as a source of topsoil where the soils are eroded, saline, low in content of organic matter, or have heavy and sticky topsoil that is difficult to handle or work.

Suitability ratings for road subgrade material are based on the performance of the soil material when excavated and used as borrow for highway subgrade. In general, the most undesirable materials are clays or organic materials. The major soil features considered in evaluating the soils for road subgrade are shear strength, compressibility, workability, shrink-swell potential, bearing capacity, and compaction characteristics. Other factors that need consideration are stability, erodibility, depth to water table, moisture content, and presence of stones or boulders.

In general, the degree of limitations and soil features were rated according to the severity of the problems they might cause during the construction and maintenance of engineering practices. The soil features shown for a given soil were based on the normal profile of that soil, as shown in table 2. Variation in the profile may change the ratings of the soil for use in some structures and practices.

Soil features considered in selecting locations for highways are depth to bedrock, flooding hazards, traffic-supporting capacity, and shrink-swell potential.

The factors considered for foundations for low buildings are those features and qualities of undisturbed soils that affect the suitability for supporting foundations of buildings less than three stories high. The foundations of a building transmit the weight of the structure onto the natural, undisturbed soils. It is the substratum of the soil that usually provides the base for foundations, and therefore, it is the material which should be evaluated. The Unified Classification System was used for evaluating the soils in terms of their bearing capacity, shrink-swell potential, and shear strength.

Soil features that determine the limitations for septic tank filter fields and sewage lagoons are permeability, ground-water levels, flooding hazards, slope, depth to rock or other impervious materials, and creviced material that may cause pollution of water supplies.

Steel pipe should have a protective coating when placed in any soil in the county to retard corrosion. Corrositivity ratings are given for soils of the county for uncoated steel based on soil conditions at a depth of 4 feet.

Soils suitable for pond reservoir areas have a low seepage rate. The factors considered for farm pond embankments are those features and qualities of disturbed soils that affect their suitability for constructing embankments. Both the subsoil and substratum are evaluated where they are contrasting in character and have significant thickness for use as borrow. The features that affect suitability are stability, compaction characteristics, susceptibility to piping, shrink-swell potential, compacted permeability, compressibility, erodibility, and content of gypsum.

Soil features that affect agricultural drainage are permeability, depth of the soil to layers that influence the rate of water movement in the soil, and the depth to the water table. Drainage generally is not a concern in Terrell County.

Formation and Classification of Soils

This section discusses the five factors of soil formation and how they affected the formation of the soils in Terrell County. It also discusses the processes of horizon differentiation and classifies the soils by higher categories.

Factors of Soil Formation

The five major factors of soil formation are climate, plants and animals, parent material, relief, and time. The nature of a soil depends on the combination of these five factors. Each of the factors is important in the formation of every soil. The relative importance of each differs from place to place. In some places one factor is dominant, and in other places another factor is dominant. It is the interaction of these five factors, however, that is of first importance in determining the present nature of every soil. These five factors as they relate to the soils of Terrell County are discussed in the following paragraphs.

The interrelationships among the five factors of soil formation are complex. Although the effects of any one factor are difficult to isolate, it is convenient to discuss each factor of soil formation separately and to indicate some of their probable effects. One should keep in mind that the factors interact continually in the processes of soil formation and that the interactions determine the kind of soil that forms.

Climate.—The climate of the past geologic ages has influenced the deposition of parent material and the carving of the landscape. The recent climate, including rainfall, temperature, humidity, evaporation, and wind, has been important in the formation of soils in Terrell County. Water and temperature have been the most important.

The limited rainfall has been sufficient to dissolve minerals and relocate them in the soil to form mineral layers such as caliche. All soils still have free lime throughout the profile because not enough water has passed through them to leach out the lime. Water erodes and transports earth materials from one area and deposits it on another. Water is involved in nearly all the chemical and physical interactions in soil development.

The great fluctuation of daily temperature causes rapid expansion and contraction of exposed rock surface and helps to crack and disintegrate it. The detached debris accumulates and becomes part of a soil.

Dry air and winds increase evaporation of moisture and transpiration of plants, thereby decreasing the effects of rainfall and the amount of vegetation. Soils of the county have a moisture deficiency for a large part of the year. They are also low in content of organic matter.

Plants and animals.—Vegetation, micro-organisms, earthworms, insects, and other forms of life that live on and in the soil contribute to its development. The type and amount of vegetation are important. They are determined partly by the climate and partly by the kind of parent material.

The stony uplands of the grassland zone are dominated by juniper and sotol and such grasses as side-oats grama, green sprangletop, cane bluestem, and black grama. In the desert shub zone, the dominant plants are creosotebush and lechuguilla and such grasses as chino grama, red grama, and three-awn.

Overflow areas of valleys generally have most of the vegetation, such as mesquite and catclaw and various native grasses. Tarbush, mesquite, and burrograss dominate the well-drained Reagan soils of valleys, and creosote-bush and three-awn dominate the gravelly Sanderson and Upton soils. Tobosa and mesquite dominate the slowly surface drained Dalby clay soils.

The few trees have had little effect on soil development. Decaying grasses distribute organic matter on the soil surface and darken the surface layer of some

soils. Soils that have a good dense cover of vegetation generally have a darker and thicker surface layer than those that have a sparse cover.

Micro-organisms help to maintain and improve soil structure by breaking down organic matter into humus and by making available a supply of plant nutrients. If the grasses and other plants can obtain more nutrients, they produce more roots, stems, and leaves, which under natural conditions are returned to the soil. The light-colored soils of uplands do not have as much microbian activity in them as the soils in overflow areas that are moist more frequently.

Worms, rodents, and other burrowing animals and insects have influenced soil formation. They mix the soil, aerate it, and provide channels for penetration of water.

Parent material.—Rock formations which are naturally exposed in Terrell County belong to the Cretaceous geologic age *(6,* 7*)*. Formations of both the Upper and Lower Cretaceous age are present. These formations are concealed in only a few places by later deposits.

Both soils and vegetation are influenced by the nature and character of the rock formations on which they occur. The rate at which the formation eroded has shaped the landscape. Rock formations that are resistant to weathering developed flat to rolling areas, and easily eroded rock formations developed steep hills and bluffs.

Formation sequence of the Upper Cretaceous age is Austin Chalk, Boquillas Flags, Buda limestone, and Grayson. They are exposed in the southern and southeastern part of the county.

The Austin Chalk formation is pale-yellow, very finely crystalline limestone. It occurs over the Boquillas Flags formation and is the youngest of the Cretaceous formations. Areas of exposures are gently sloping to undulating. Desert plants such as creosotebush, red grama, and tridens occur on the Lozier soils, which dominate these outcrops.

The Boquillas Flags formation is mostly thinly bedded layers of yellowish and gray limestone and siltstones with loamy earth partings. Areas of this formation are exposed in the southeastern part of the county, mainly along Lozier and Thurston Canyons, Indian Creek, and the Rio Grande. The formation is characterized by conical hills and by long, flat-topped buttes and mesas. These areas have formed Lozier soils, which support desert type vegetation. Flagstone from the formation is mined for building stones.

The Buda limestone formation is yellowish-gray to pale yellowish-brown, microcrystalline, massive porcelaneous limestone and clayey nodular limestone. It is exposed in the southern part of the county. The northern limits of its exposure around Dryden form low hills and gently rolling tablelands. Other exposures extend along the breaks of the Rio Grande and its tributaries. The principal soils formed from Buda limestone are Ector soils.

The Grayson formation, formerly known as Del Rio Clay, is mostly yellowish-brown, silty, limy, laminated claystone. It outcrops in a limited area around Dryden and near the Rio Grande in the southwestern part of the county. It is generally less than 40 feet in thickness. The larger areas of weathered, soft, brownish-yellow clay and the alluvial fans from the base of the outcrops are mapped as Badland. Only a few widely scattered plants grow in these areas.

Formations of the Lower Cretaceous age are Georgetown, Kiamichi, and Edwards limestone. These include all the exposed Cretaceous formations underlying the Grayson formation. Exposures are extensive throughout northern and western parts of the county. Soils developed over these formations are the very shallow, stony Ector soils.

The Georgetown limestone formation is light-gray, finely crystalline, very fossiliferous limestone, mostly massive beds. Nodules and very thin, discontinuous nodular beds of flint are present throughout.

The Kiamichi formation is light-gray, microcrystalline, thin-bedded, clayey limestone. Only thin exposures of this formation occur in the county, mainly on walls of canyons.

The Edwards limestone formation is gray, finely crystalline, massive limestone. Flint is not as abundant as in the Georgetown limestone. Edwards limestone apparently makes up the bulk of the Comanchean Cretaceous formations exposed in the county. It is easily recognized by its characteristic weathering into steep bluffs.

After the carving of valleys and streams in the limestone, soil materials were washed from limestone uplands and deposited in them. The valley deposits are of Recent and Pleistocene age. They consist mainly of clay, sand, gravel, and boulders from formations of the Cretaceous age. They are mostly in valleys, where they were deposited by the drainage. These alluvial deposits are known to be about 225 feet thick in Downie Canyon and 212 feet thick in Sanderson Canyon near Sanderson *(4)*. Evidently these canyons were much deeper in Early Pleistocene times than they are at present. There are a few areas of outwash deposits, mainly from the Rio Grande, composed of rock and gravel of sedimentary and igneous sources. Other deposits are old stream deposits.

At this time no geologic mapping of these later deposits has taken place. There are apparently three distinct ages of these deposits. The older deposits formed the Upton soils. They are gravelly alluvium that is well cemented with caliche. The intermediate deposits have distinct zones of lime accumulations, and the young deposits are the recent, relatively unaltered sediment of fine and gravelly alluvium. Work done in the Davis Mountains indicates that the older deposits occurred during a relatively humid period. The other two deposits were in the following cycle of gullying and sedimentation. They took place under relatively arid conditions *(1)*. These latter two units have been regionally correlated recently with recent alluvial deposits in Arizona and New Mexico that range in age from 5,000 radiocarbon years to the present *(5).*

Relief.—This limestone region is characterized by nearly level plateaus, which are broken by hills and steep canyons that are separated by nearly level valleys. A pronounced influence of topography on soil formation is encountered in this area. The normal geologic erosion removes soil materials from slopes. As a result, the depth of steeper sloping soils is very shallow.

Very shallow soils over limestone contain thicker lime coatings on stones on gently sloping areas than they do on steeper areas. The soils on level to gently sloping mesas generally have developed caliche horizons.

Soils in alluvium of valleys have a deeper A horizon in level areas than on sloping areas.

Soils on sloping areas generally contain more gravel than soils on level areas.

Relief acts to condition the redistribution of matter and climatic energy without contributing anything new to soil formation. Slopes are important in the relation to soil moisture conditions and profile development.

Time.—Many characteristics of a soil are determined by the length of time the soil-forming processes have acted upon the soil material. Some materials that have been in place for only a short time have not been influenced enough by climate or living organisms to develop genetically related horizons.

The most mature soils are those that have been in place a long time and have distinct horizons of lime accumulations. These soils occur on uplands.

Processes of Horizon Differentiation

Several processes were involved in the formation of horizons in the soils of Terrell County. These processes are: (1) accumulation of organic matter, (2) formation of

clay minerals, and (3) translocation of calcium carbonates and other bases. In most soils one or more of these processes has been active in the development of horizons.

The accumulation of organic residue in the soils has been important for soil structure. Most of the accumulation takes place in the upper part of the soil with the content of organic matter decreasing with depth. The surface horizon generally has the highest content of organic matter.

The formation of clay minerals has occurred through the weathering process of soil minerals. In many of the soils most of the clay mineral was formed before deposition of the soil material. In other soils a large part of the clay was formed after deposition, mainly in the wet zone, which commonly extends to a depth of about 12 to 30 inches. No translocation of clay has taken place.

Translocation of calcium carbonates and other bases has formed a ca horizon in several soils of the county. Translocation of calcium carbonate has been mainly by water, which has carried lime downward and concentrated it at the normal wetting depth of the soil.

Examples of soils that have ca horizons are Reagan and Upton.

The C horizon has been changed little since deposition and occurs at the base of the A horizon or the B horizon. The top part of the C horizon generally accumulates calcium carbonate, which is translocated from the above horizons. In such cases, a Cca horizon occurs.

The symbol R is used to indicate bedrock formation, which occurs below some soils. Ector and Lozier are soils that are very shallow over limestone bedrock.

The better developed soils of the uplands usually have an A1-B2-Cca and C horizon sequence. Those soils that formed in recent alluvial sediment of streams generally have an A1-C horizon sequence. Those soils that are very shallow over bedrock have an A1-R sequence.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as counties and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 *(3)* and later revised *(9)*. The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. It is under continual study *(8, 11)*. Therefore, readers interested in developments of the current system should search the latest literature available. The soil series of Terrell County are placed in some categories of the current system in table 4.

General Nature of the County

The information in this section is for those who wish to get a general idea of the county. Briefly discussed are the climate and vegetative and climatic zones.

Climate

By Robert B. Orton, climatologist for Texas, National Weather Service, U.S. Department of Commerce.

Terrell County has a warm, temperate, semidesert climate. Droughts occur frequently, and even with normal rainfall, soil moisture is scarce. Winters are mild and summers are long and hot.

The average annual rainfall is 11.21 inches (table 5). About three-fourths of this amount falls during the period from May through October. In May and June, much of the precipitation results from thunderstorms associated with cool fronts in the spring. Throughout the rest of the summer and early in fall, most of the precipitation occurs from local thundershowers and from showers that build up in the mountains immediately to the west, then drift eastward across the country. Snow falls so infrequently in the area that it has no significance as a source of moisture.

Average daily minimum temperature in January is about 36°F.; however, because of the dry air and abundant sunshine, the daily maximum average is about 66°F. In July, average daily maximum is 96°F., and the average minimum temperature is about 72°F.

The average date of the last 32° reading in spring is about March 16, and the first freeze in fall is November 16. Because of the unevenness of the terrain, these dates will vary considerably within the county and also from one year to the next. The length of the average growing season is 245 to 260 days.

Characteristic of the semidesert climate, relative humidity is rather low, averaging about 55 percent annually. The area receives, on an average, about 70 percent of the total possible sunshine. Mean annual lake evaporation averages about 76 to 78 inches.

Vegetative and Climatic Zones

Because of the climate, there are two distinct vegetative zones in the county: the grassland vegetative zone of the semidesert part, which receives 10 to 15 inches annual rainfall, and the desert shrub vegetative zone of the desert part, which receives 6 to 10 inches annual rainfall. The separation is made on the type and amount of native grasses, perennial forbs, and shrubs. The contrast of vegetation between the two zones is shown in figure 22.

The stony uplands of the grassland zone are dominated by juniper and sotol and such grasses as side-oats grama, green sprangletop, cane bluestem, and black grama. In the desert shrub (climatic) zone, dominant plants are creosotebush, lechuguilla, and skeletonleaf goldeneye and such grasses as chino grama, red grama, and three-awn. For the general line of separation see figure 23.

The soils in the semidesert part generally are moist 3 to 5 months in most years and are dry for more than 3 months. The soils in the desert part generally are moist 1 to 3 months and are dry for more than 6 months.

The mean annual soil temperature at a depth of 20 inches is about 70°F for both zones. The mean average soil temperature for January is 53°F., and for July it is 86°F.

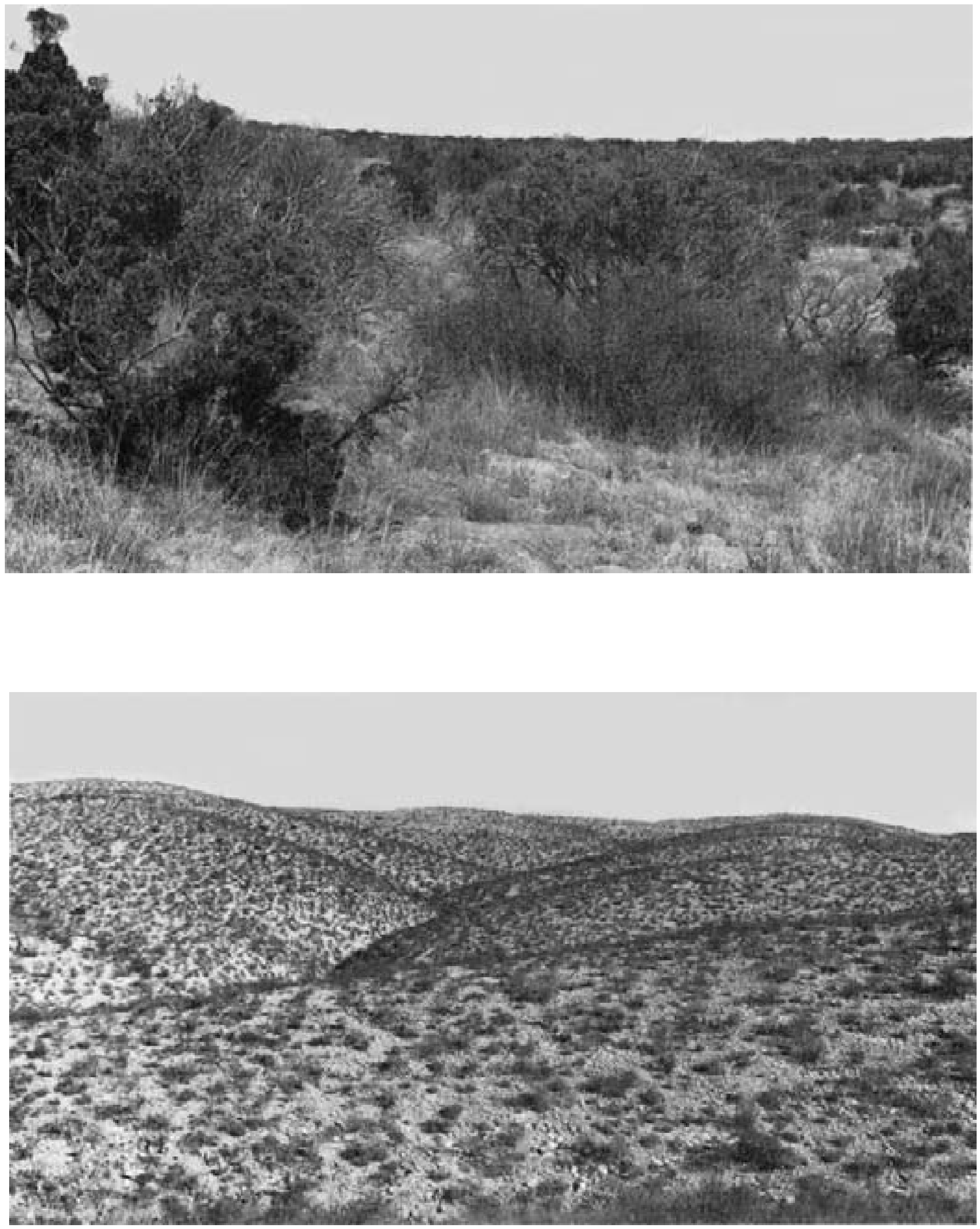


Figure 22.—Contrast of vegetation on Ector stony loam by vegetative zones Top photo shows grassland vegetative type, and bottom photo shows desert shrub vegetative type.

Figure 23.—Vegetative zone (area 1) and climatic zone (area 2).

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Glossary

ABC soil. A soil that has a complete profile, including an A, B, and C horizon.

AC soil. A soil that has an A and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be ex-posed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Decreasers. Any of the climax range plants most heavily grazed. Because they are the most palatable, they are first to be destroyed by overgrazing.

Friability. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

Increasers. Species in the climax vegetation that increase in relative amount as the more desirable plants are reduced by close grazing; increasers commonly are shorter than decreasers, and some are less palatable to livestock.

Invaders. On range, plants that come in and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface. (Most weeds are invaders).

Munsell notation. A system for designating color by degrees of the three simple variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Rootplowing. A method of brush control. A horizontal blade pulled behind a tractor cuts roots below the soil surface.

Runoff. The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Shale. A sedimentary rock formed by the hardening of clay deposits.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Stratified. Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from ad-joining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water spreading. Diverting runoff from a gully or watercourse onto gently sloping, absorptive land to conserve waste water or increase plant growth, to reduce flood peaks, or to replenish ground-water supplies.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey.

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Area	Extent
	Acres	*Percent*
Badland	6, 200	0. 4
Dalby clay	3, 400	. 2
Dev association	39, 220	2. 6
Ector soils	424, 210	27. 7
Ector-Rock outcrop complex	347, 390	22. 7
Ector-Upton association	207, 610	13. 6
Gila soils	5, 080	. 3
Glendale soils	26, 230	1. 8
Lozier soils	78, 000	5. 1
Lozier-Upton association	52, 350	3. 4
Reagan silty clay loam	79, 240	5. 2
Sanderson-Upton association	158, 020	10. 3
Upton very gravelly soils	15, 000	1. 0
Upton soils	25, 280	1. 6
Upton-Reagan-Lozier association	63, 010	4. 1
Total	1, 530, 240	100. 0

TABLE 2.—*Estimated soil properties significant to engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table. Absence of entry in a column indicates that properties are not estimated. < = less than; > = more than]

Soil series and map symbols	Depth from surface	Hydrologic group	Depth to bedrock	Classification: USDA texture	Classification: Unified	Classification: AASHO	Percentage passing sieve: No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Shrink-swell potential
	Inches		*Inches*								*Inches per hour*	*Inches per inch of soil*	
Badland: Ba. Too variable to be rated.													
Dalby: Da	0-34 34-50 50-70	D	>60	Clay Silty clay Clay loam	CH CH CL or CH	A-7 A-7 A-6 or A-7	95-100 90-100 90-100	90-100 85-100 85-100	90-100 80-100 80-100	85-95 80-95 75-85	<0.06 <0.06 0.06-0.2	0.14-0.16 0.14-0.16 0.14-0.16	High. High. High.
Dev: De	0-30	B	>30	Very gravelly loam	GC, GM-GC, SC, or SM-SC	A-2	15-45	35-45	15-45	15-35	2.0-6.3	0.05-0.10	Low.
*Ector: Ec, Er, Eu. For Upton part of Eu, see Upton series.	0-4 4-15	C	4-12	Gravelly loam Fractured hard limestone.	GC or SC	A-1 or A-2	30-70	30-65	15-50	15-35	0.63-2.0	0.05-0.10	Low.
Gila: Ga	0-50	B	>50	Loam	ML	A-4	95-100	85-90	80-90	70-80	0.63-2.0	0.15-0.20	Low.
Glendale: Ge	0-60	B	>60	Clay loam	CL	A-6	90-100	90-100	90-100	85-95	0.2-0.63	0.15-0.20	Moderate.
*Lozier: Lo, Lu. For Upton part of Lu, see Upton series.	0-8 8-13	D	8-13	Gravelly loam Limestone.	GM	A-2	20-50	20-50	20-50	15-35	0.63-2.0	0.05-0.10	Low.
Reagan: Re	0-32 32-70	B	>60	Silty clay loam Clay loam	CL CL	A-6 or A-7 A-6	85-100 85-100	80-100 80-100	80-100 80-100	85-95 80-90	0.63-2.0 0.63-2.0	0.15-0.20 0.15-0.20	Low. Low.
*Sanderson: Su. For Upton part of Su, see Upton series.	0-60	B	>60	Gravelly loam	SM or ML	A-2 or A-4	50-80	50-65	40-75	30-60	0.63-2.0	0.10-0.15	Low.
*Upton: Up, Ur, Uu. For Lozier part of Uu, see Lozier series. For Reagan part of Ur, see Reagan series.	0-12 12-20	C	6-20	Gravelly loam Indurated caliche.	SM or ML	A-2 or A-4	50-80	40-75	40-75	30-60	0.63-2.0	0.05-0.10	Low.

TABLE 3.—*Engineering interpretations of the soils*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table. Absence of entry in a column indicates that characteristics are too variable for the material to be classified]

Soil series and map symbols	Suitability as source of—: Topsoil	Suitability as source of—: Road subgrade	Degree of limitations and soil features affecting—: Highway location	Foundations for low buildings	Septic tank filter fields	Sewage lagoons	Farm ponds: Reservoir areas	Farm ponds: Embankments	Corrosivity class for uncoated steel and contributing soil features[1]
Badland: Ba. Too variable to be rated.									
Dalby: Da	Poor: clay texture.	Poor: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor traffic-supporting capacity; high shrink-swell potential.	Severe: poor bearing capacity; high shrink-swell potential.	Severe: very slow permeability.	Slight	None to slight	Moderate: fair slope stability.	High: conductivity.
Dev: De	Poor: 35 to 65 percent coarse fragments; calcium carbonate equivalent more than 30 percent.	Good	Severe: flooding hazard.	Severe: flooding hazard.	Severe: flooding hazard.	Severe: permeability of more than 2 in./hr.; 35 to 65 percent coarse fragments.	Severe: moderately rapid permeability.	Severe: poor resistance to piping and erosion.	Moderate: conductivity.
*Ector: Ec, Er, Eu. For Upton part of Eu, see Upton series.	Poor: 35 to 60 percent coarse fragments.	Poor: 4 to 12 inches of soil material.	Severe: depth to bedrock is 4 to 12 inches.	Severe: depth to bedrock is 4 to 12 inches.	Severe: depth to bedrock is 4 to 12 inches.	Severe: depth to bedrock is 4 to 12 inches.	Severe: depth to bedrock is 4 to 12 inches.	Severe: 4 to 12 inches of borrow material.	High: conductivity.
Gila: Ga	Good	Fair: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: fair traffic-supporting capacity; flooding hazard.	Severe: flooding hazard.	Moderate: flooding hazard.	Moderate: moderate permeability.	Severe: moderate permeability; calcareous.	Moderate: fair slope stability; medium compressibility; poor resistance to piping and erosion.	High: conductivity.
Glendale: Ge	Fair: clay loam texture.	Fair: fair traffic-supporting capacity; moderate shrink-swell potential.	Moderate: fair traffic-supporting capacity; moderate shrink-swell potential; flooding hazard.	Severe: flooding hazard.	Moderate: moderately slow permeability; flooding hazard.	Moderate: moderately slow permeability.	Moderate: moderately slow permeability.	Moderate: medium compressibility; good to fair resistance to piping and erosion.	High: conductivity.
*Lozier: Lo, Lu. For Upton part of Lu, see Upton series.	Poor: 35 to 60 percent coarse fragments.	Poor: 3 to 13 inches of soil material.	Severe: depth to bedrock is 3 to 13 inches.	Severe: depth to bedrock is 3 to 13 inches.	Severe: depth to bedrock is 3 to 13 inches.	Severe: depth to bedrock is 3 to 13 inches.	Severe: depth to bedrock is 3 to 13 inches.	Severe: 3 to 13 inches of borrow material.	High: conductivity.
Reagan: Re	Poor: calcium carbonate equivalent 15 to 35 percent.	Fair: fair traffic-supporting capacity.	Moderate: fair traffic-supporting capacity.	Moderate: fair bearing capacity.	None to slight	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: medium compressibility; good to fair resistance to piping and erosion.	High: conductivity.
*Sanderson: Su. For Upton part of Su, see Upton series.	Poor: 35 to 50 percent coarse fragments.	Good	None to slight	Moderate: fair bearing capacity.	None to slight	Moderate: moderate permeability; 35 to 50 percent fragments.	Severe: moderate permeability; calcareous.	Moderate: fair slope stability; slight to medium compressibility; poor resistance to piping and erosion.	High: conductivity.
*Upton: Up, Ur, Uu. For Lozier part of Uu, see Lozier series. For Reagan part of Ur, see Reagan series.	Poor: 35 to 55 percent coarse fragments.	Poor: 6 to 20 inches of suitable material.	Severe: depth to indurated caliche is 6 to 20 inches.	Severe: depth to indurated caliche is 6 to 20 inches.	Severe: depth to indurated caliche is 6 to 20 inches.	Severe: depth to indurated caliche is 6 to 20 inches.	Severe: depth to indurated caliche is 6 to 20 inches.	Severe: 6 to 20 inches of borrow material.	High: conductivity.

[1] Corrosivity class for concrete is low for all soils in the county.

TABLE 4.—*Classification of soils*

Series	Family	Subgroup	Order
Dalby	Fine, mixed, thermic	Typic Torrerts	Vertisols.
Dev	Loamy-skeletal, carbonatic, thermic	Cumulic Haplustolls	Mollisols.
Ector	Loamy-skeletal, carbonatic, thermic	Aridic Lithic Rendolls	Mollisols.
Gila	Coarse-loamy, mixed, calcareous, thermic	Typic Torrifluvents	Entisols.
Glendale	Fine-silty, mixed, calcareous, thermic	Typic Torrifluvents	Entisols.
Lozier	Loamy-skeletal, carbonatic, thermic	Lithic Torriorthents	Entisols.
Reagan	Fine-silty, mixed, thermic	Ustollic Calciorthids	Aridisols.
Sanderson	Loamy-skeletal, carbonatic, thermic	Ustollic Camborthids	Aridisols.
Upton	Loamy, carbonatic, thermic, shallow	Typic Paleorthids	Aridisols.

463-924—74——3

TABLE 5.—*Precipitation data*

[From records kept at Sanderson, 1934–63. Elevation 2,800 feet]

Month	Average total [1]	Greatest daily [1]	One year in 10 will have—		Average number of days with precipitation of—			Snow and sleet	
			Less than—	More than—	0.10 inch or more [2]	0.50 inch or more [2]	1.00 inch or more [2]	Monthly average [3]	Monthly maximum [3]
	Inches	*Inches*	*Inches*	*Inches*				*Inches*	*Inches*
January	0.62	0.95	0	1.43	2	(4)	0	0.1	2.3
February	.44	.72	0	1.03	2	(4)	0	.1	1.0
March	.27	.59	0	.74	1	0	0	0	
April	.73	1.11	0	2.28	2	1	(4)	0	0
May	1.63	2.20	.04	2.89	3	1	(4)	0	0
June	1.26	1.55	0	3.17	3	1	(4)	0	0
July	1.19	1.80	0	2.95	2	1	(4)	0	0
August	.95	2.28	0	2.49	2	(4)	(4)	0	0
September	1.94	3.05	0	4.19	3	1	(4)	0	0
October	1.32	1.58	0	3.13	3	1	1	0	0
November	.35	.80	0	.93	1	0	0	(5)	(5)
December	.51	.54	.01	1.39	1	0	0	0	0
Year	11.21	3.05	4.94	16.47	25	6	1	.2	2.3

[1] Average length of record 24 years.
[2] Average length of record 10 years.
[3] Average length of record 15 years.
[4] Less than half a day.
[5] Trace.

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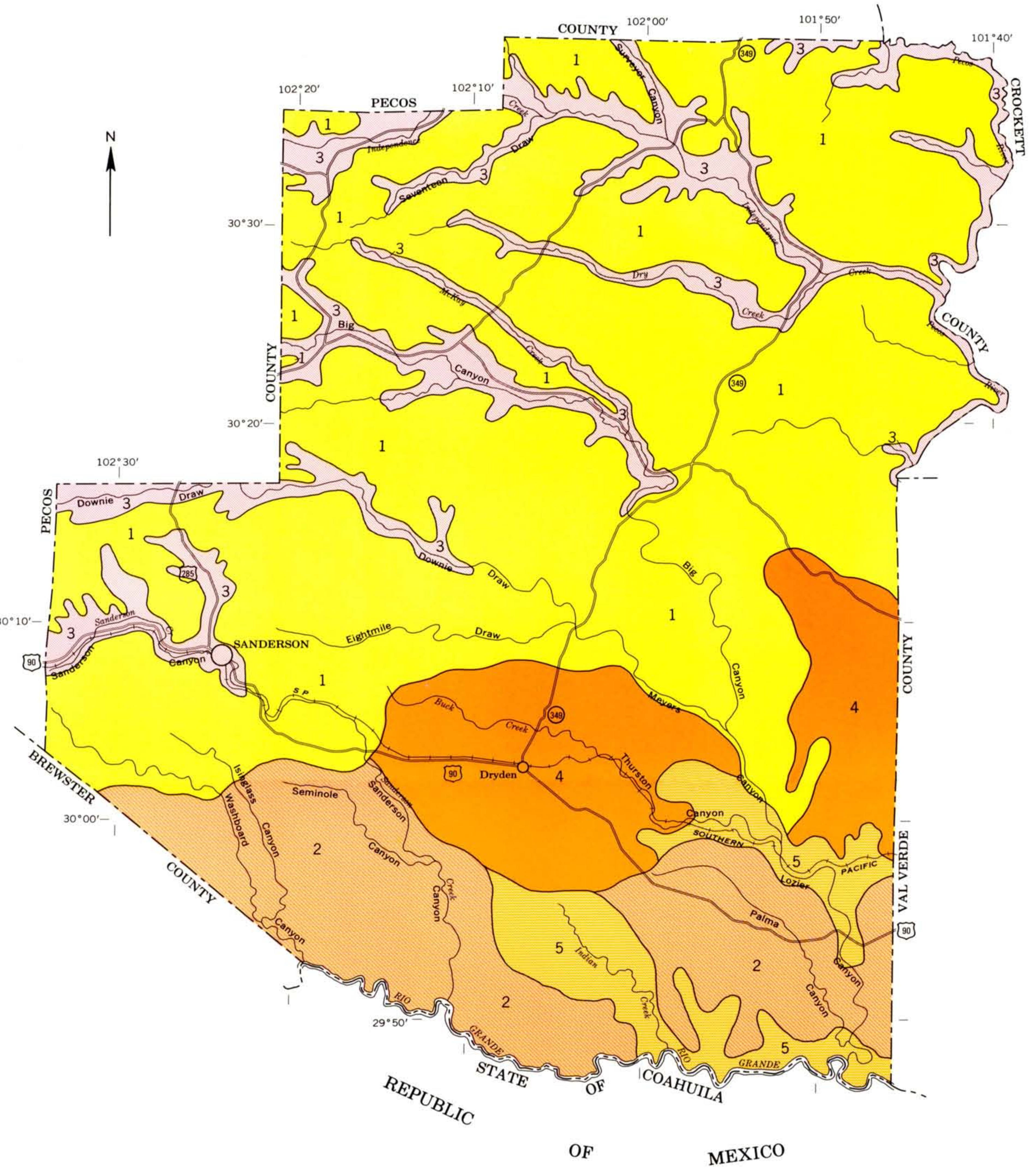


SOIL ASSOCIATIONS *

1	Ector-Rock outcrop association: Moderately steep to steep, very shallow stony loams and stony clay loams and rock outcrops
2	Ector-Lozier association: Nearly level to steep, very shallow, gravelly, flaggy, or stony loams and clay loams
3	Sanderson-Reagan association: Nearly level to gently sloping, deep gravelly loams, gravelly clay loams, and silty clay loams
4	Upton-Lozier-Reagan association: Nearly level to hilly, very shallow to deep, gravelly or flaggy loams and silty clay loams
5	Lozier-Upton association: Nearly level to steep, very shallow and shallow gravelly loams and clay loams

* Texture as used in this legend refers to texture throughout for the major soils.

Compiled in 1972

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TEXAS AGRICULTURAL EXPERIMENT STATION

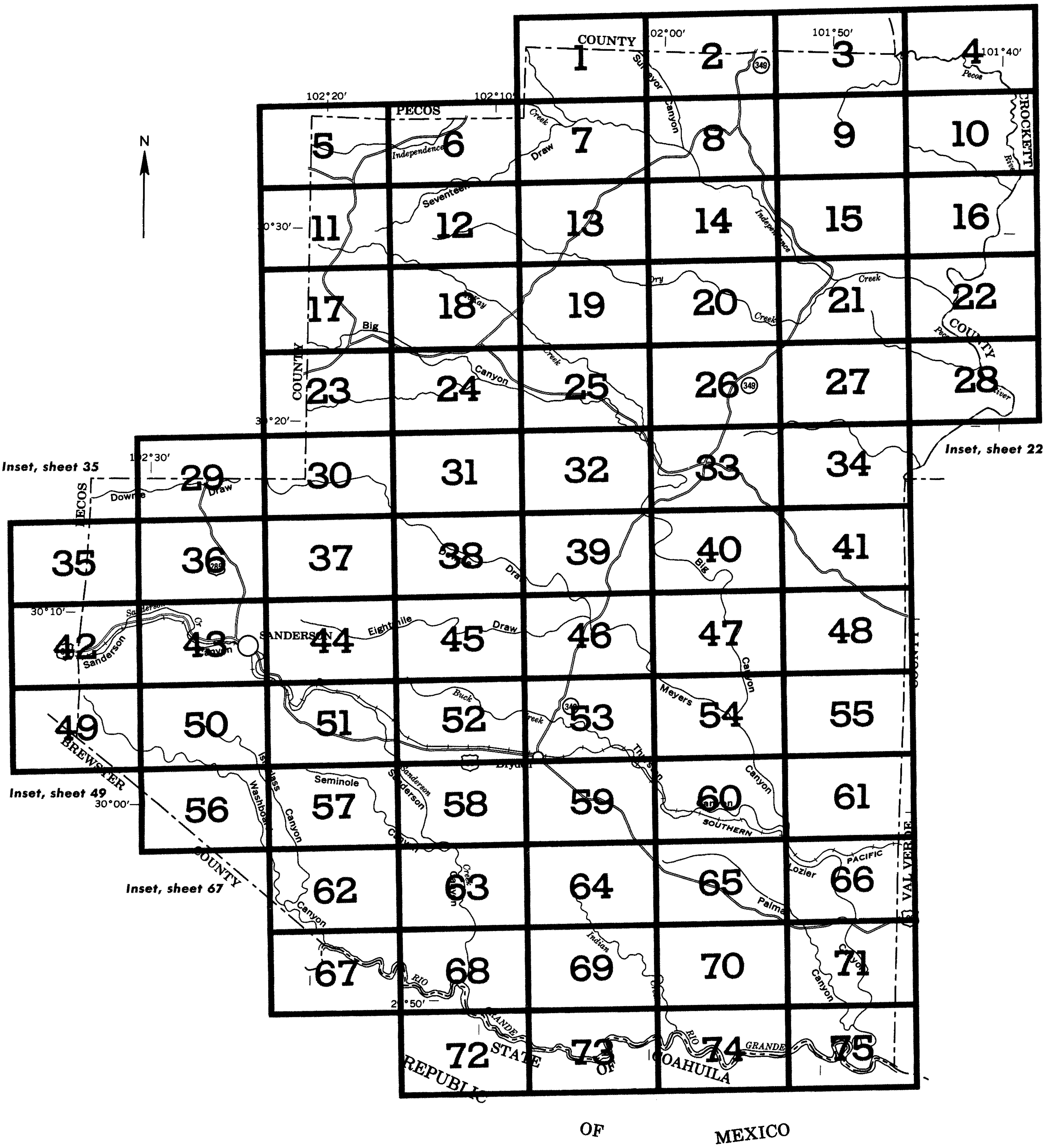
GENERAL SOIL MAP

TERRELL COUNTY, TEXAS

Scale 1:380,160

1 0 1 2 3 4 5 6 Miles

This map is for general planning. It shows only the major soils and does not contain sufficient detail for operational planning.



INDEX TO MAP SHEETS

TERRELL COUNTY, TEXAS

Scale 1:380,160

1 0 1 2 3 4 5 6 Miles

SOIL LEGEND

SYMBOL	NAME
Ba	Badland
Da	Dalby clay
De	Dev association
Ec	Ector soils
Er	Ector-Rock outcrop complex
Eu	Ector-Upton association
Ga	Gila soils
Ge	Glendale soils
Lo	Lozier soils
Lu	Lozier-Upton association
Re	Reagan silty clay loam
Su	Sanderson-Upton association
Up	Upton very gravelly soils
Ut	Upton soils
Uz	Upton-Reagan-Lozier association

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State, farm or ranch

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit (G.P.)

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully

1

TERRELL COUNTY, TEXAS NO. 1

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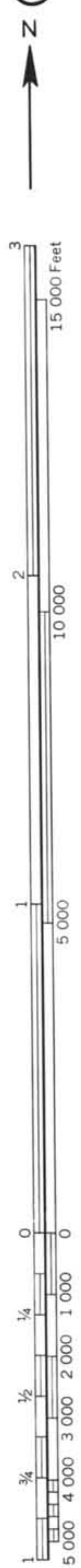
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 2



(Joins sheet 1)

(Joins sheet 8)

(Joins sheet 3)

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TERRELL COUNTY, TEXAS NO. 3

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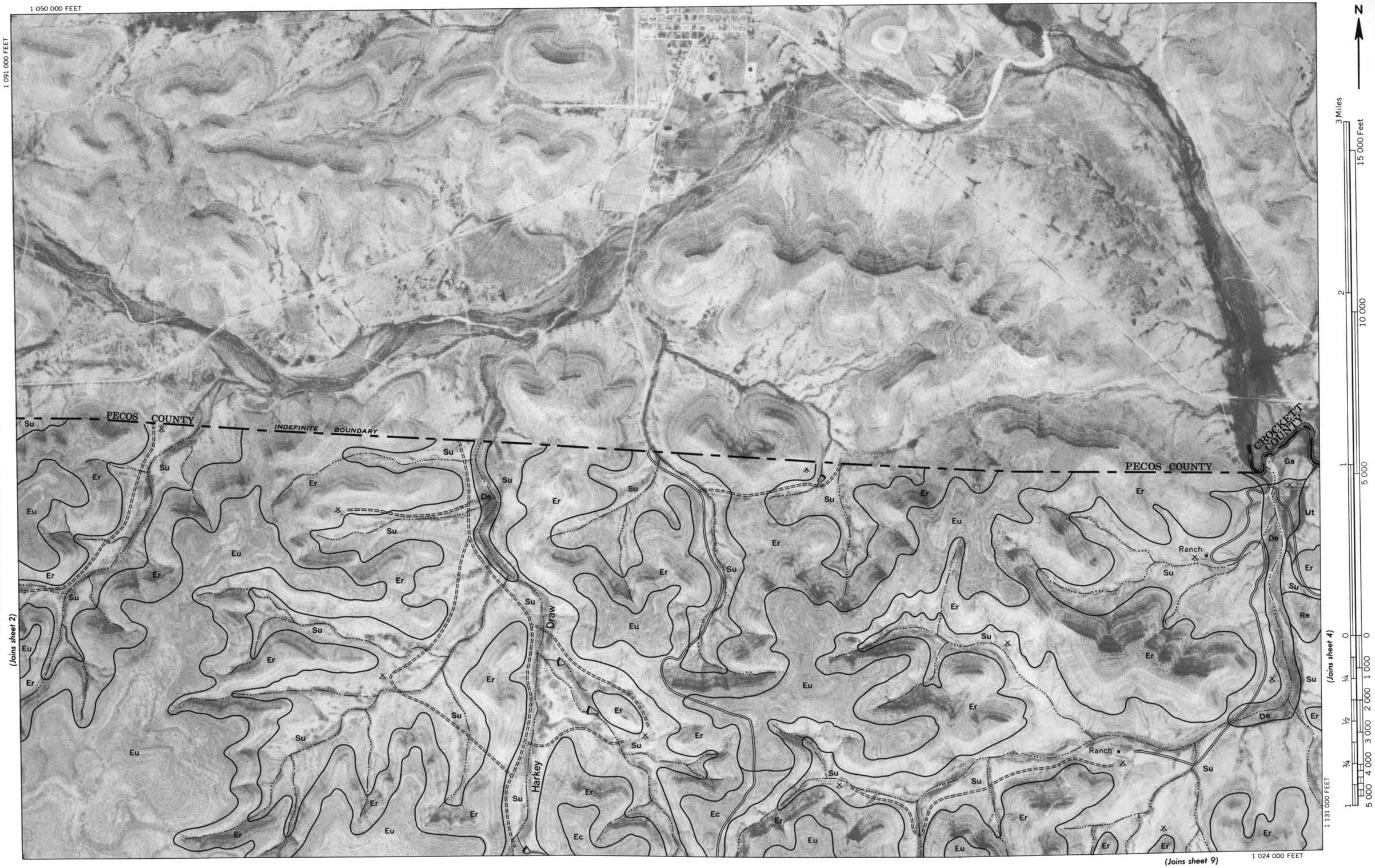

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1 171 000 FEET

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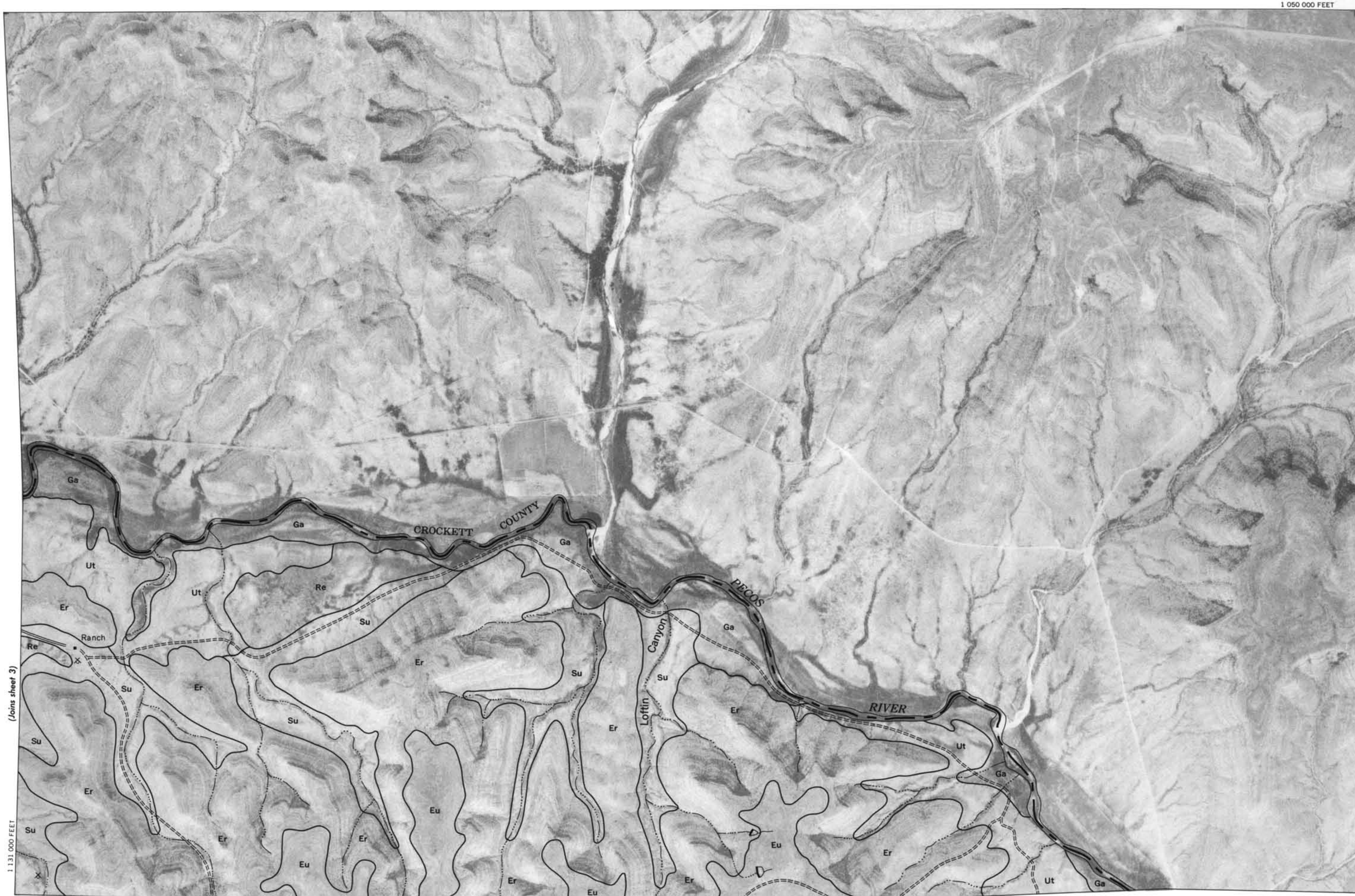
1 131 000 FEET



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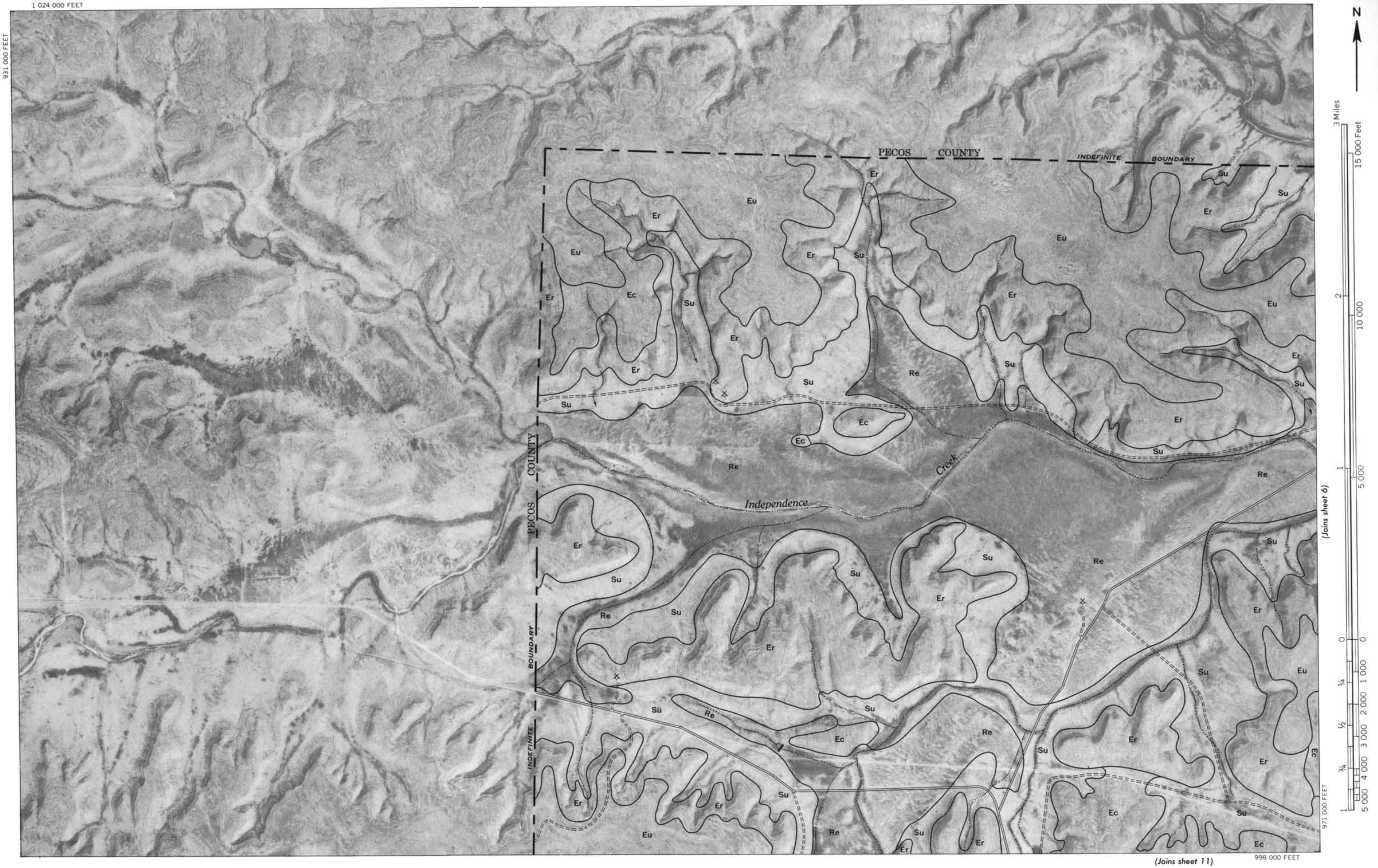
TERRELL COUNTY, TEXAS NO. 4



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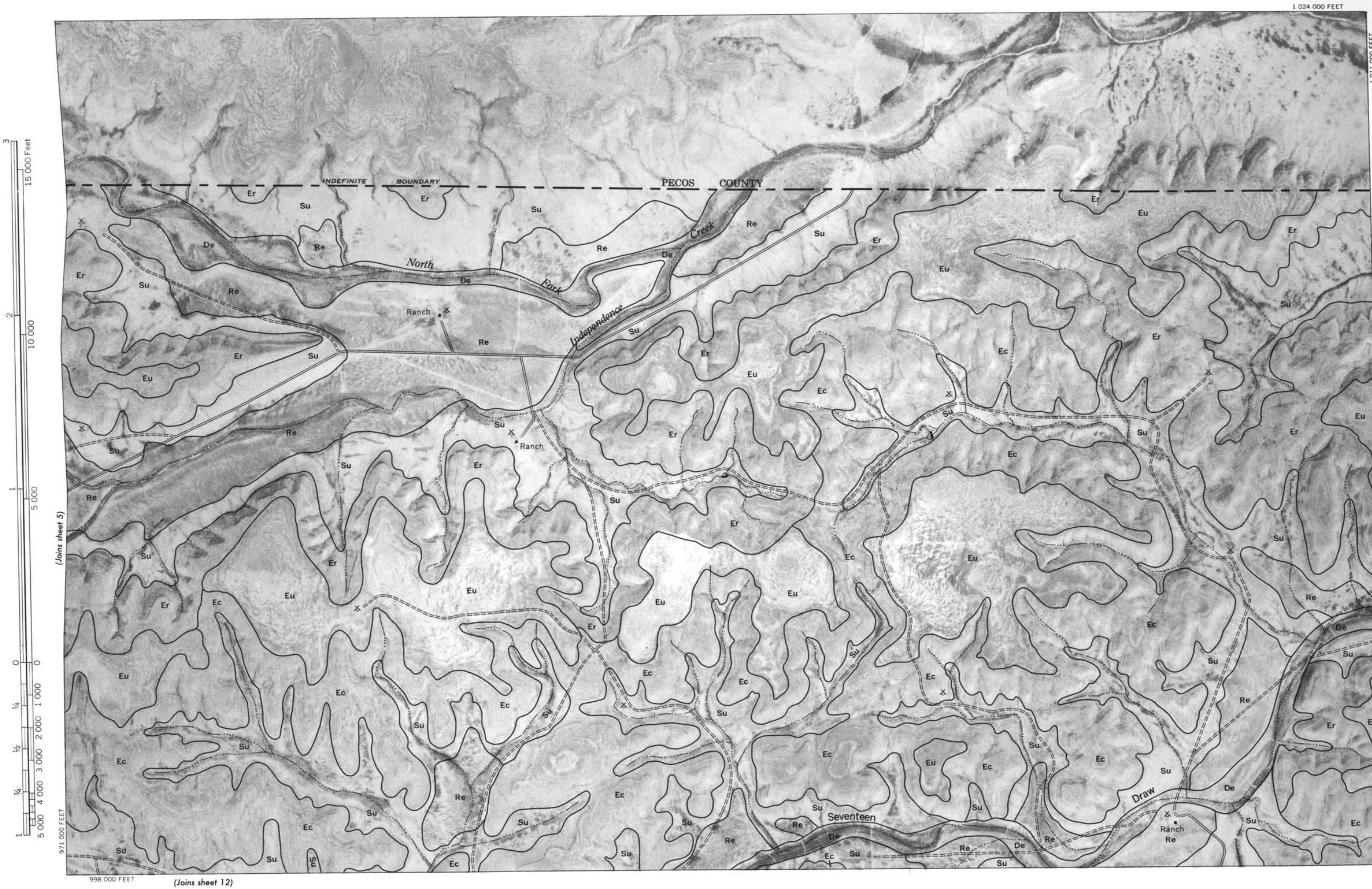

TERRELL COUNTY, TEXAS NO. 6

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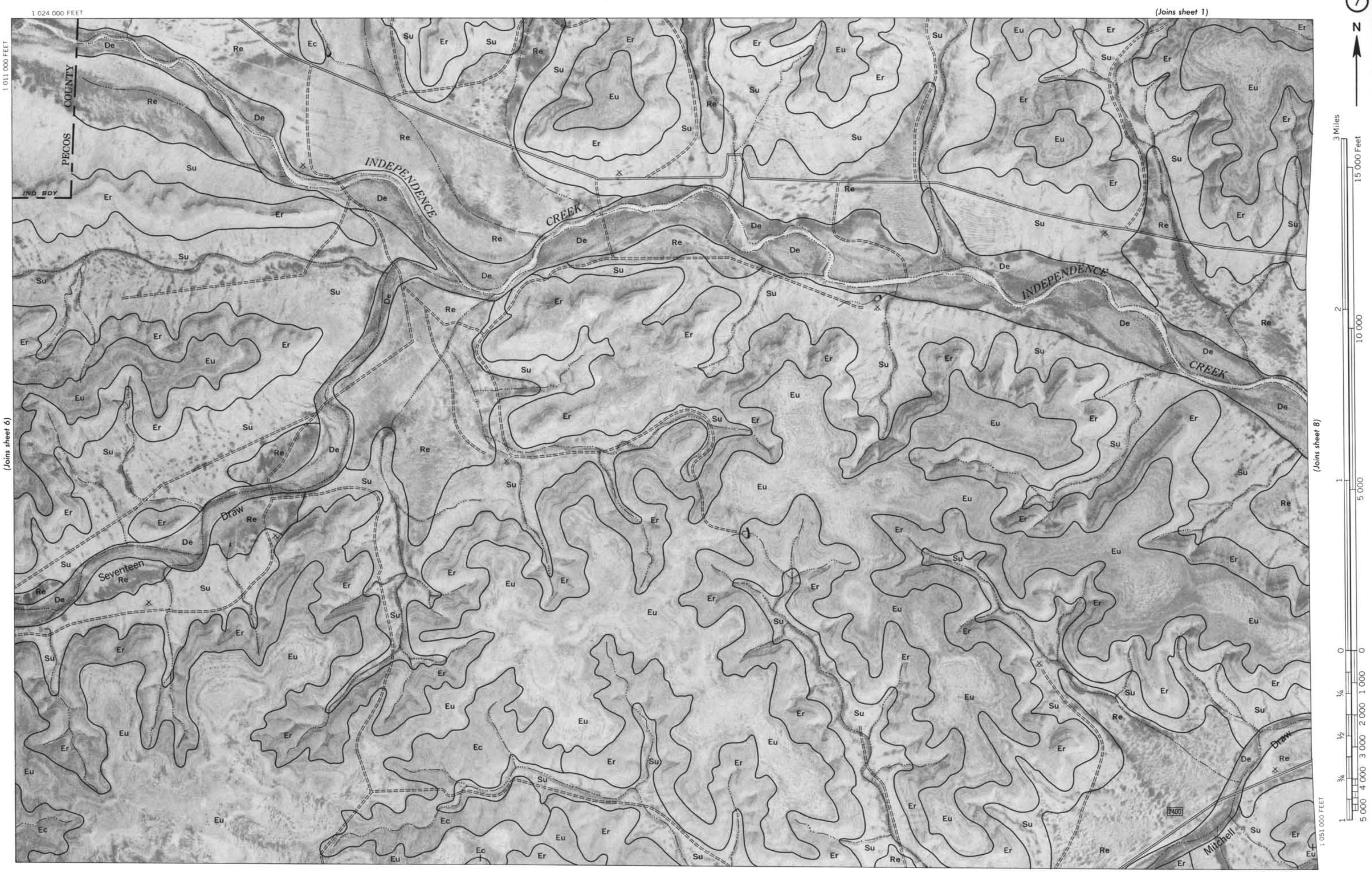
TERRELL COUNTY, TEXAS — SHEET NUMBER 7



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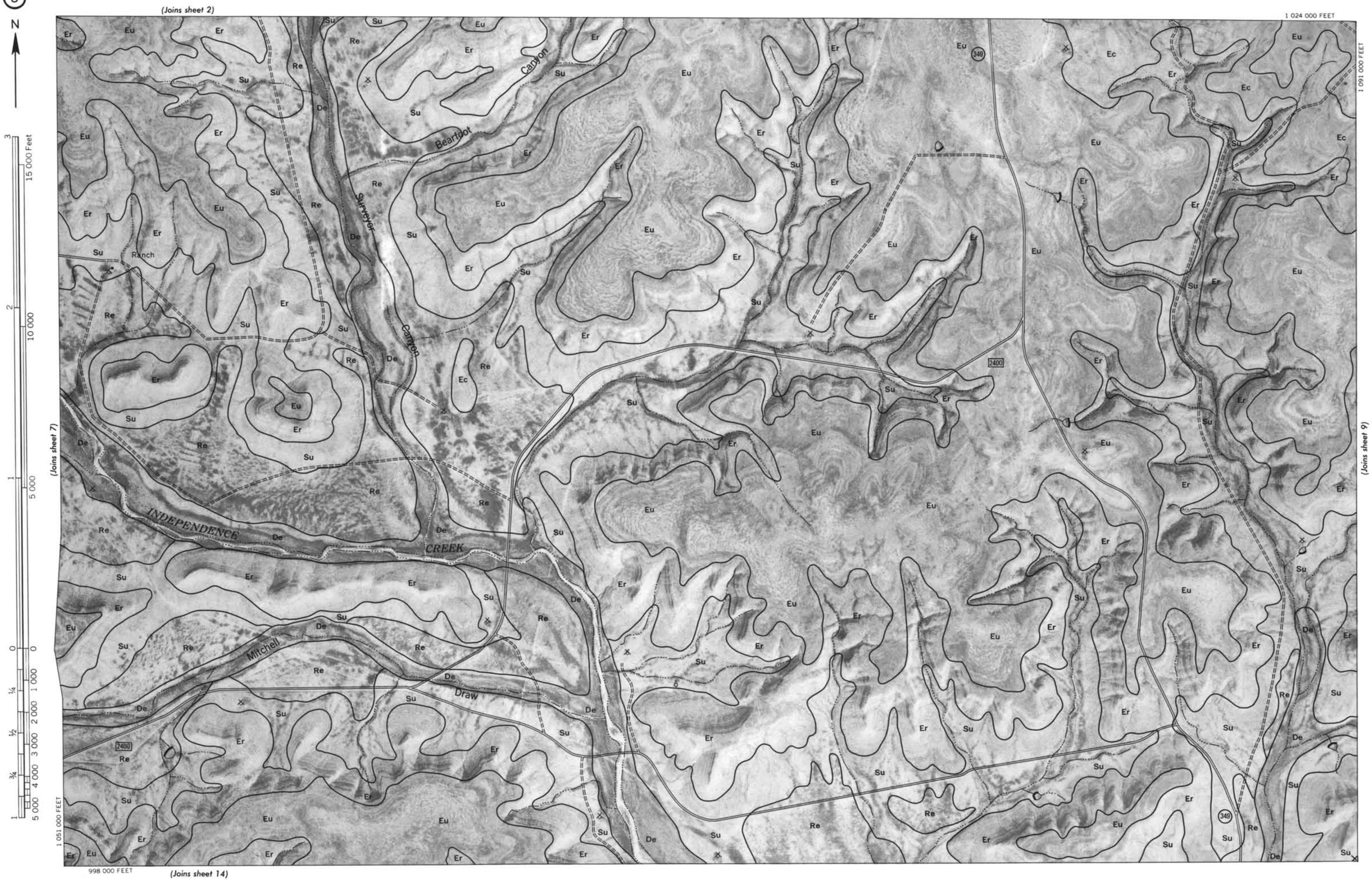
TERRELL COUNTY, TEXAS — SHEET NUMBER 8



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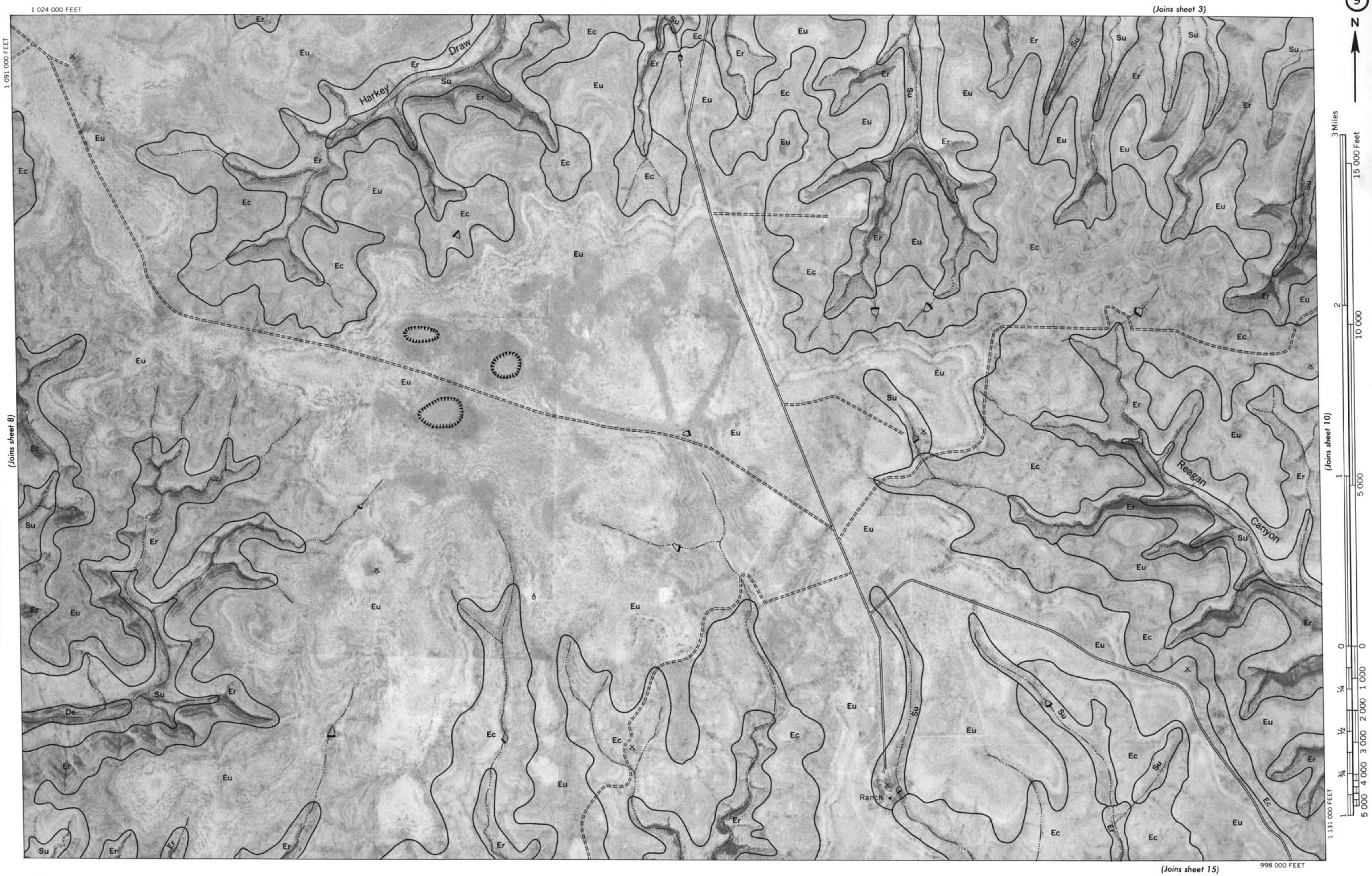

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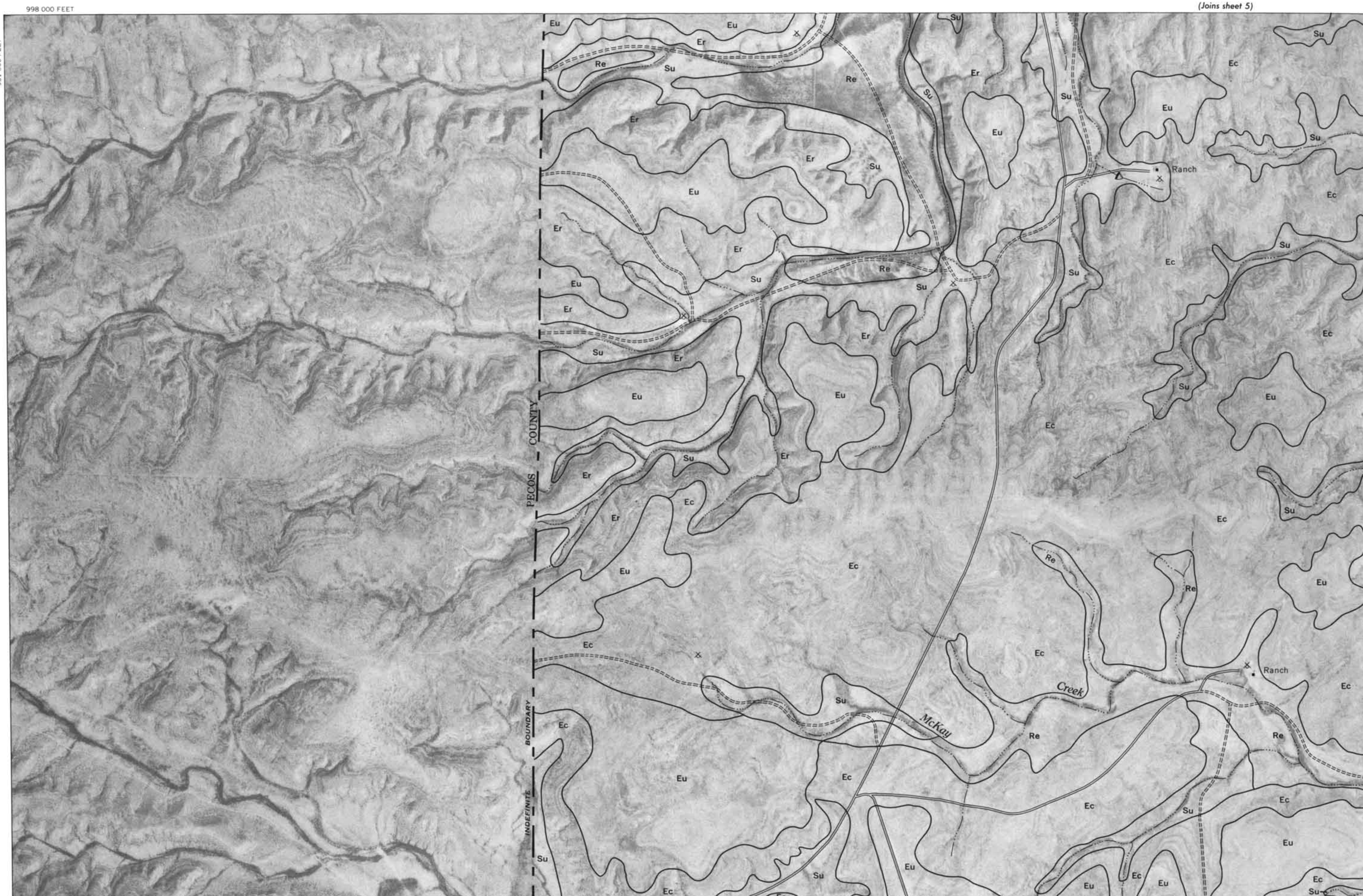
(11)

998 000 FEET

931 000 FEET

(Joins sheet 5)



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15 000 Feet
10 000
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2 000
3 000
4 000
5 000

(Joins sheet 12)

971 000 FEET

972 000 FEET

(Joins sheet 17)

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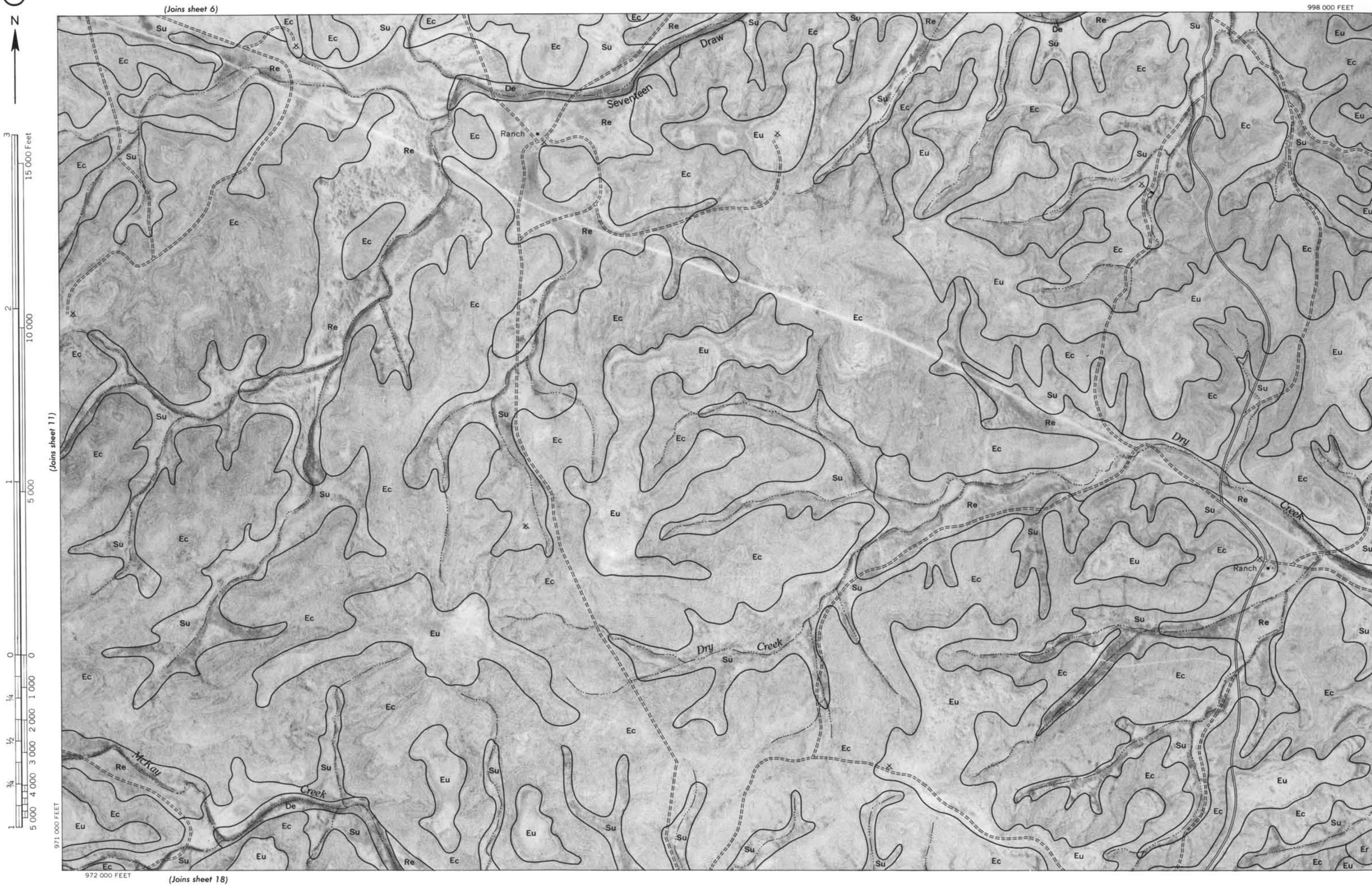
TERRELL COUNTY, TEXAS — SHEET NUMBER 12



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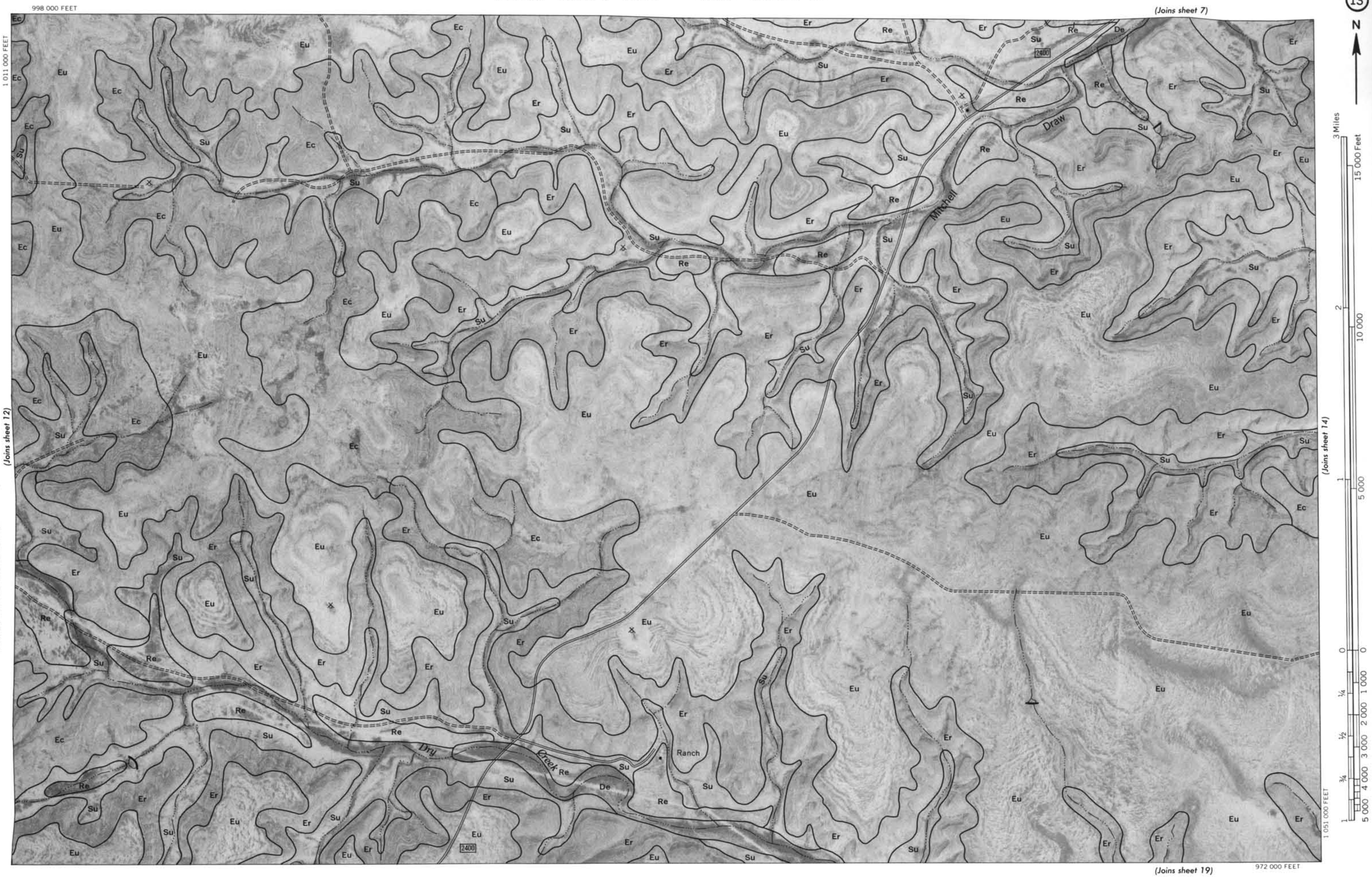

TERRELL COUNTY, TEXAS NO. 13

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TERRELL COUNTY, TEXAS — SHEET NUMBER 14

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TERRELL COUNTY, TEXAS — SHEET NUMBER 16

(Joins sheet 10)

N

3 — 15 000 Feet
2 — 10 000
1 — 5 000
0 — 0
¼ — 1 000
½ — 2 000
¾ — 3 000 — 4 000
1 — 5 000

(Joins sheet 15)

(Joins sheet 22)

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

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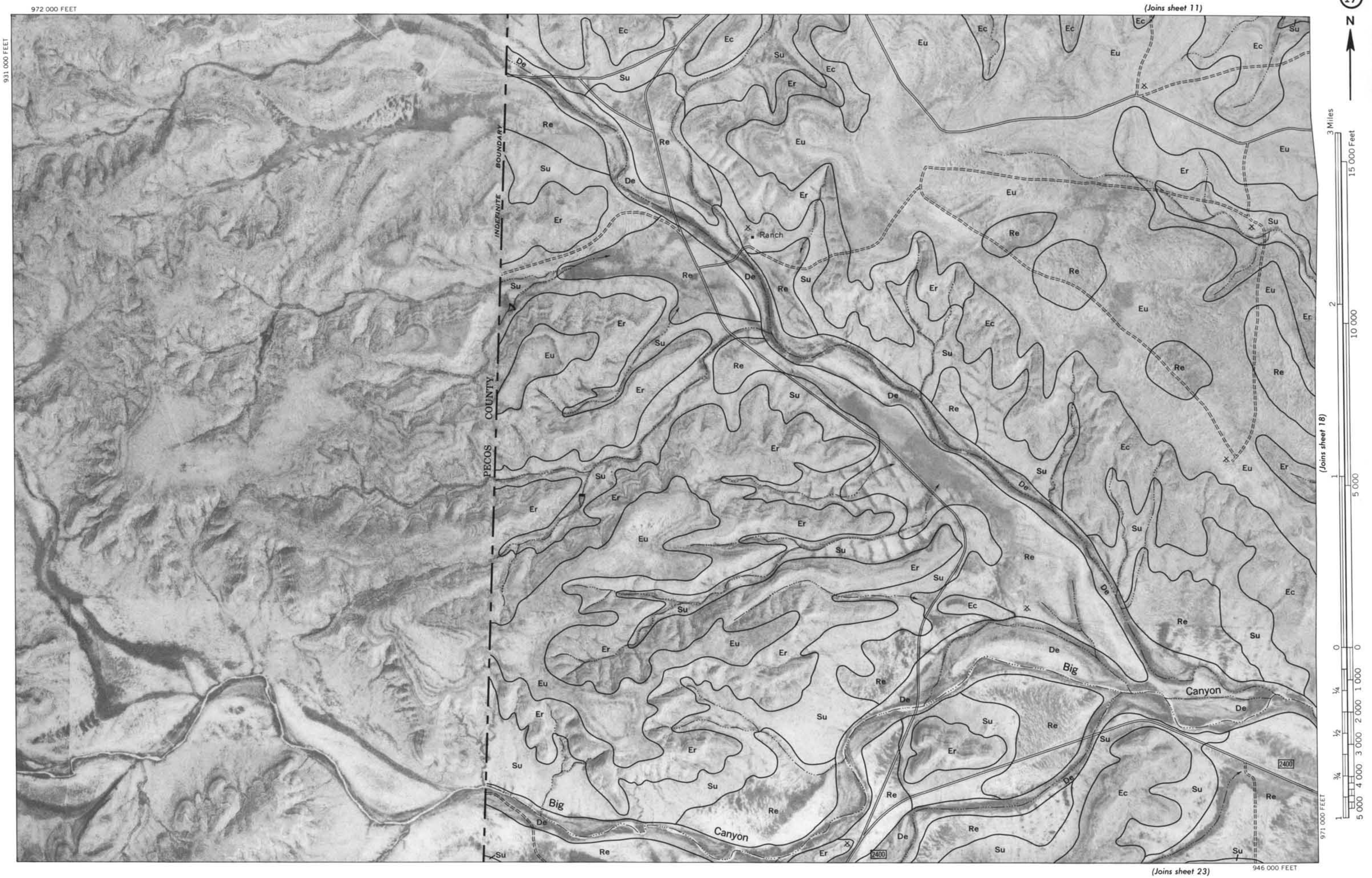
17



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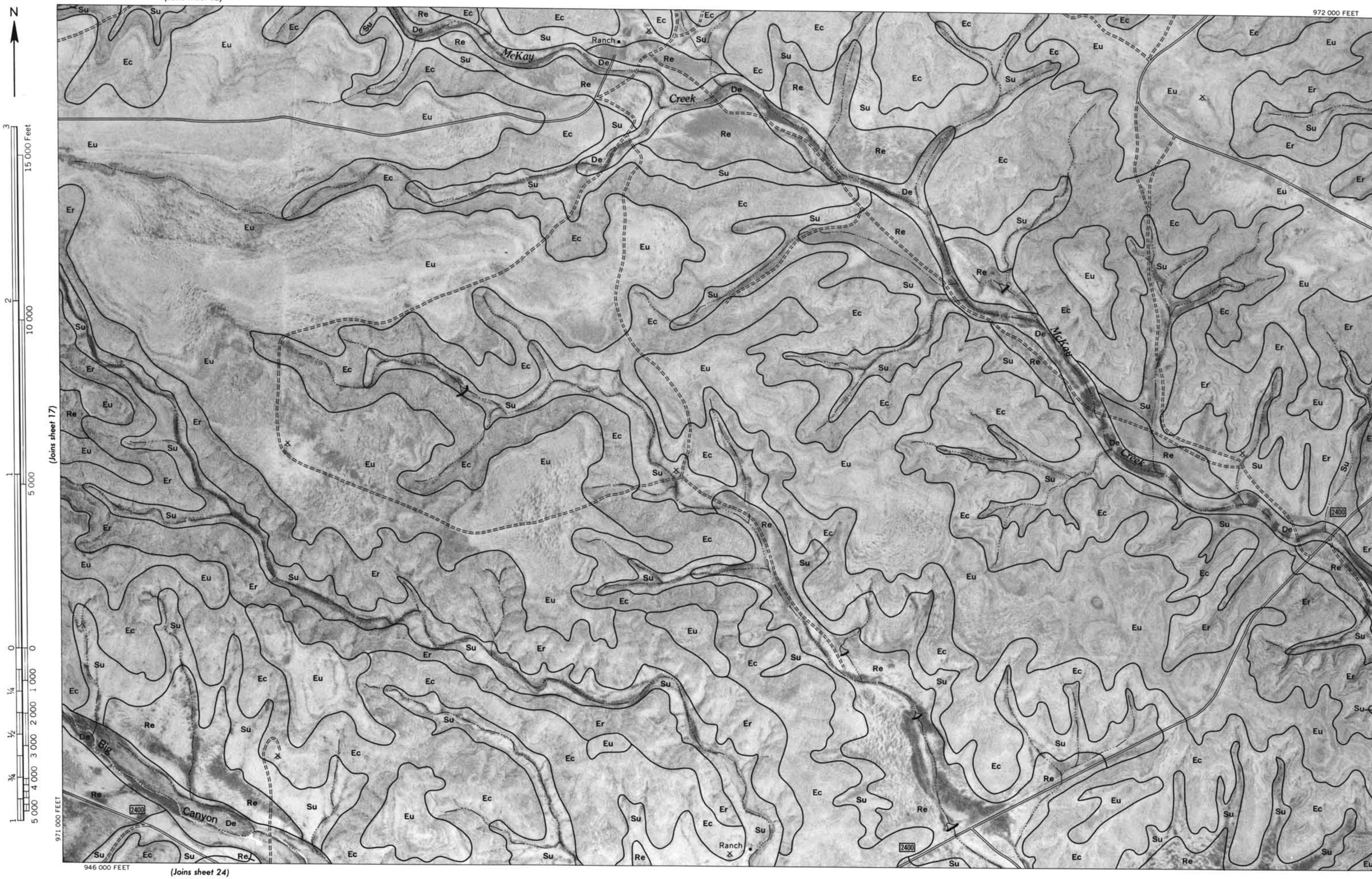
TERRELL COUNTY, TEXAS — SHEET NUMBER 18



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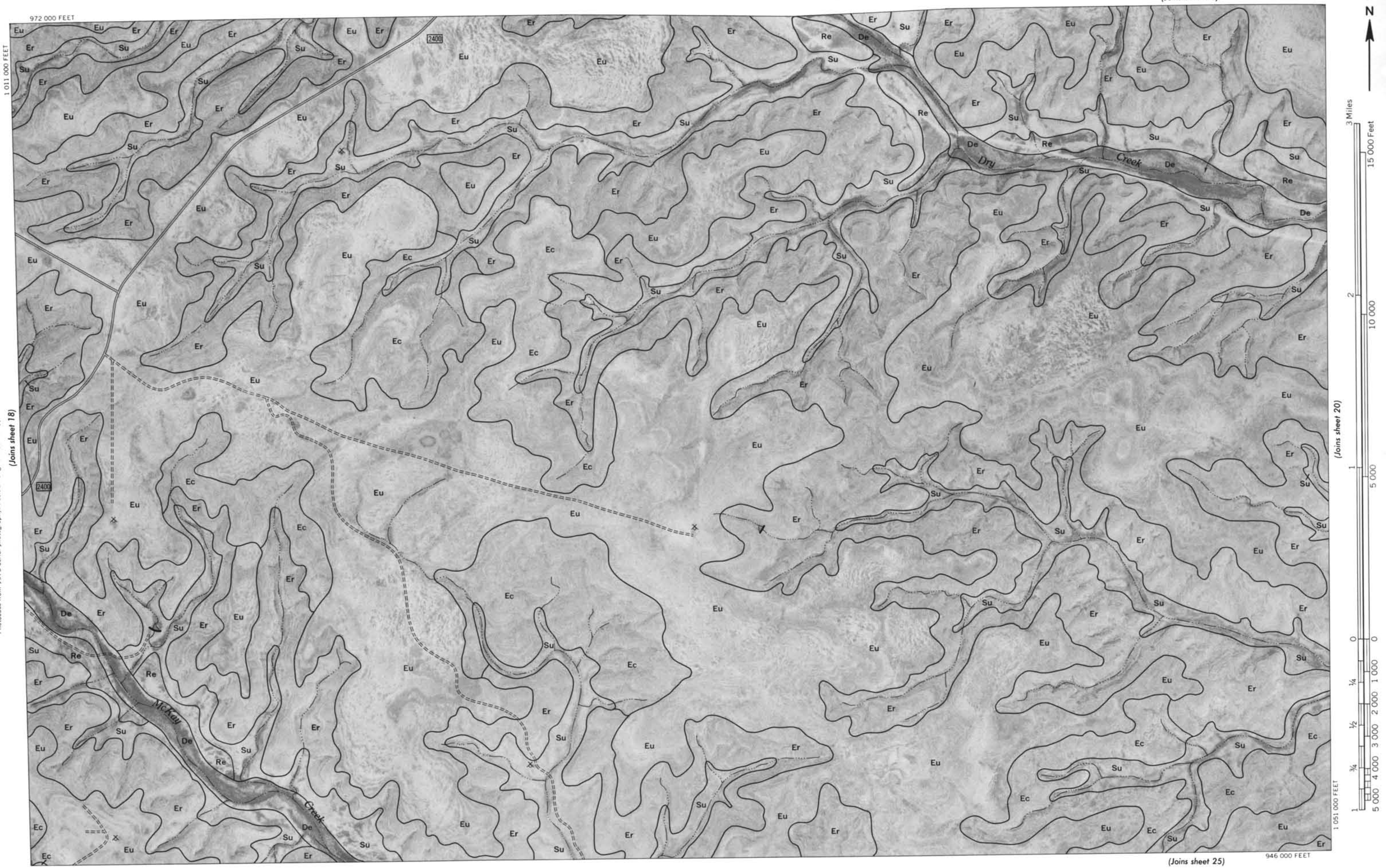

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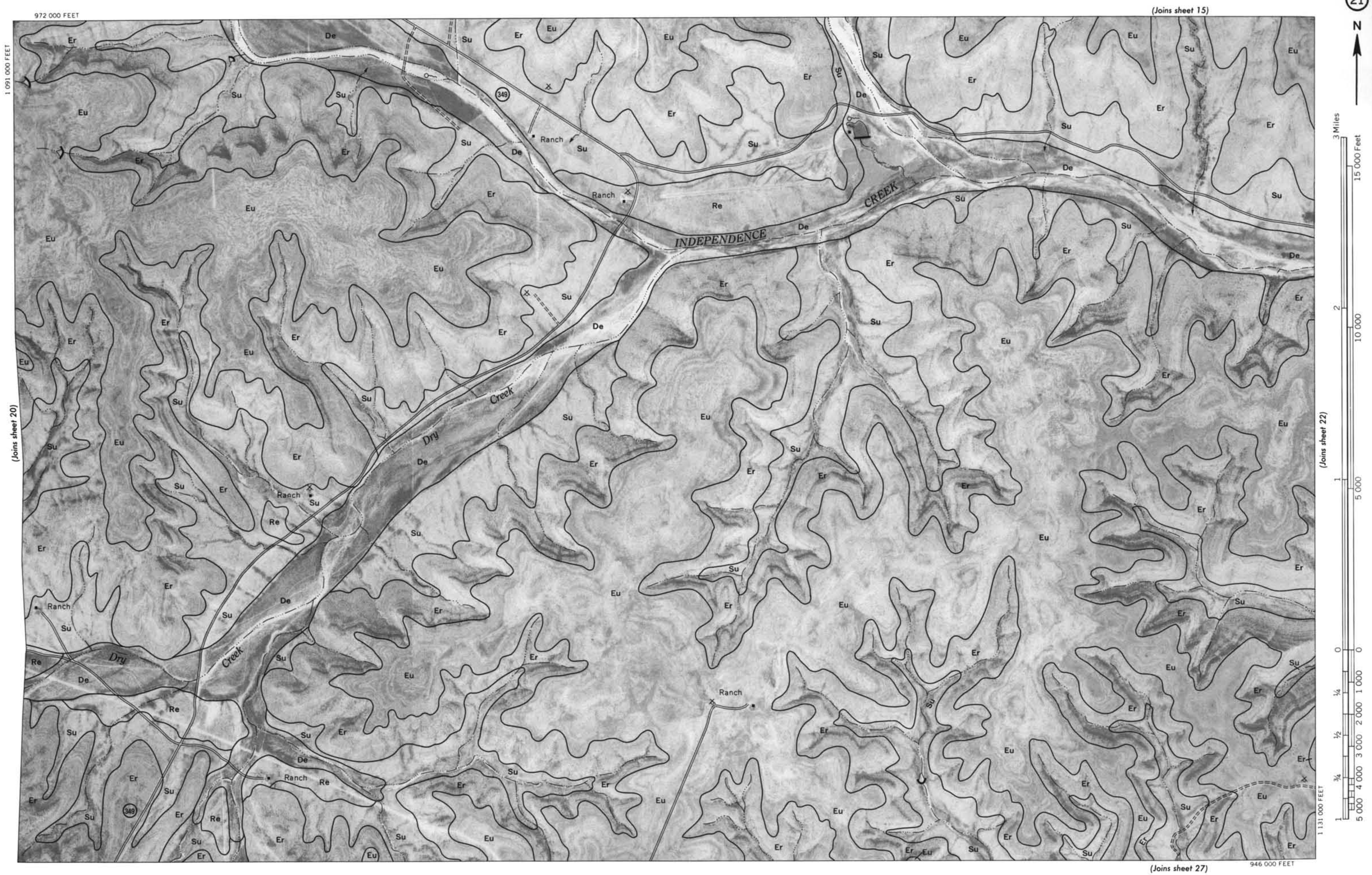
TERRELL COUNTY, TEXAS NO. 20



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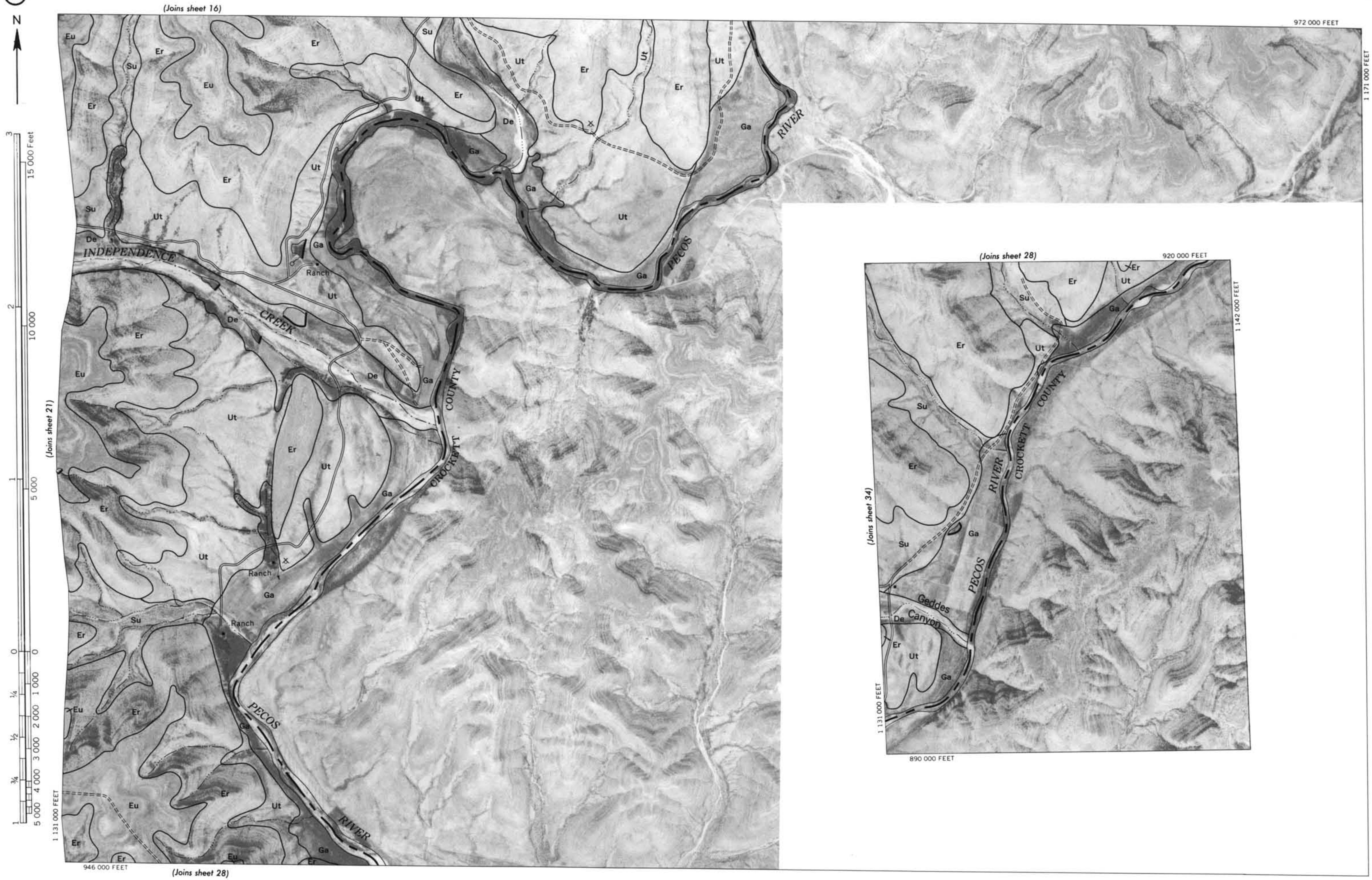

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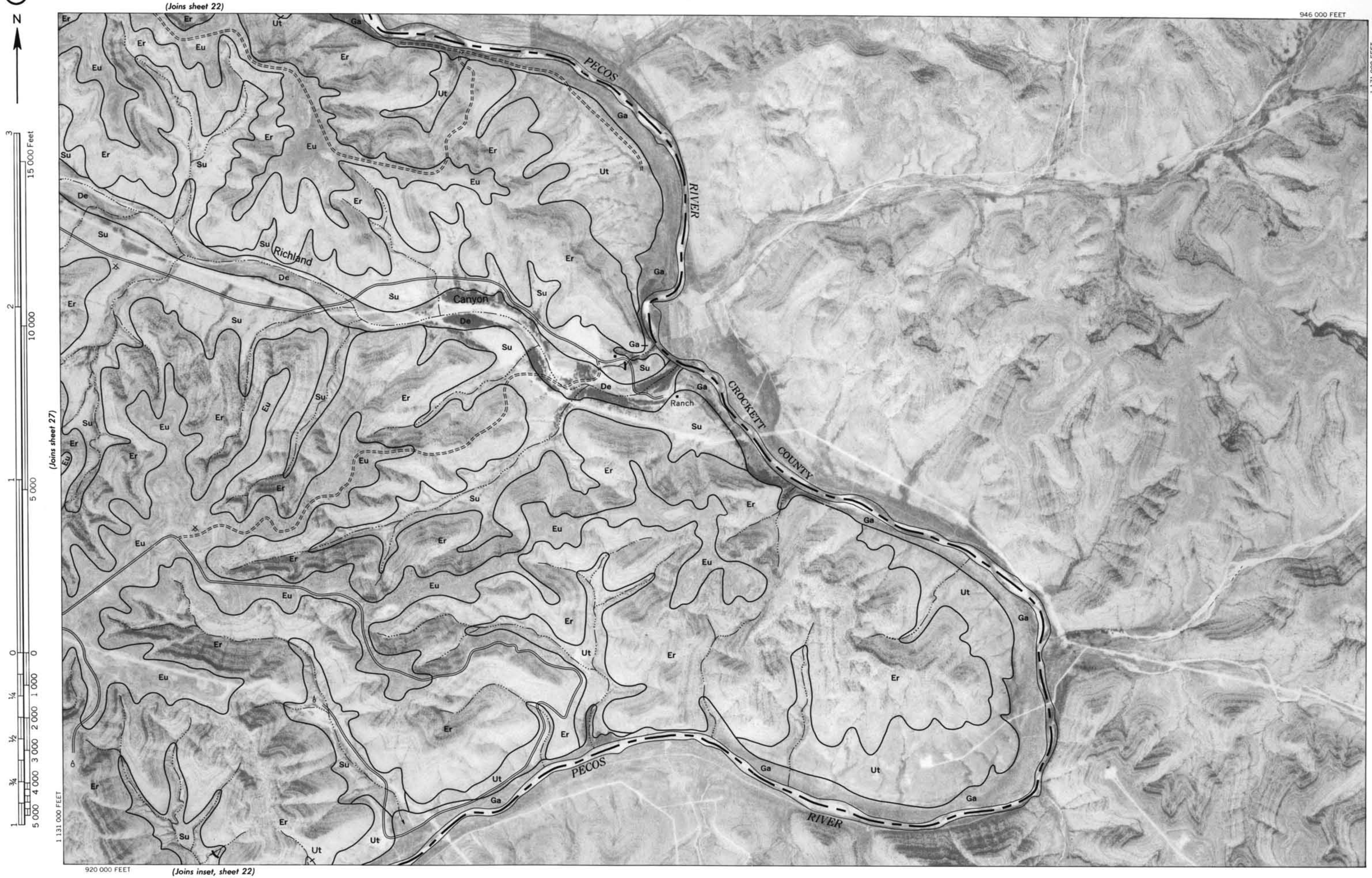
TERRELL COUNTY, TEXAS — SHEET NUMBER 28



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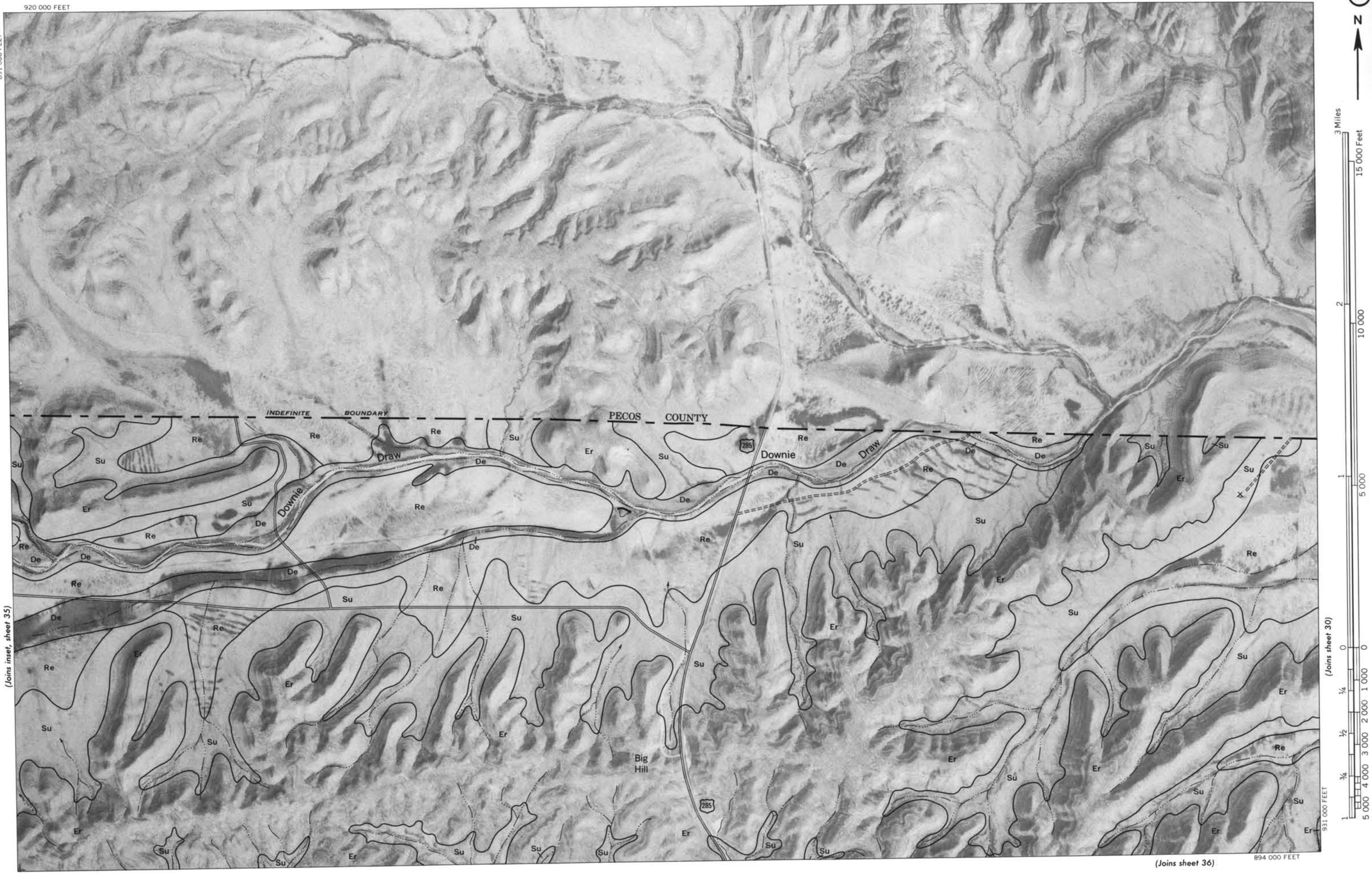

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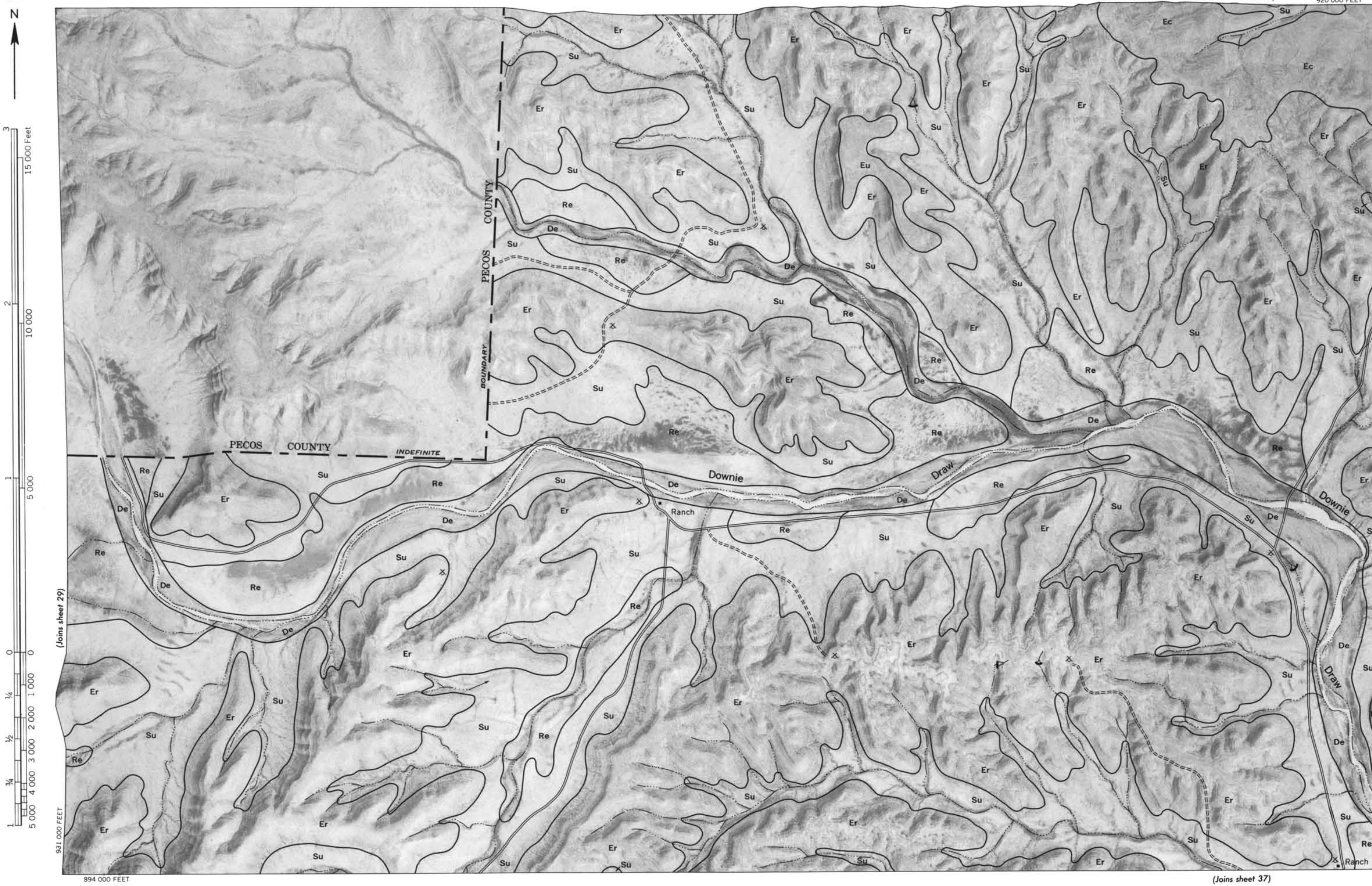
TERRELL COUNTY, TEXAS — SHEET NUMBER 30



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TERRELL COUNTY, TEXAS — SHEET NUMBER 31

(31)

TERRELL COUNTY, TEXAS NO. 31

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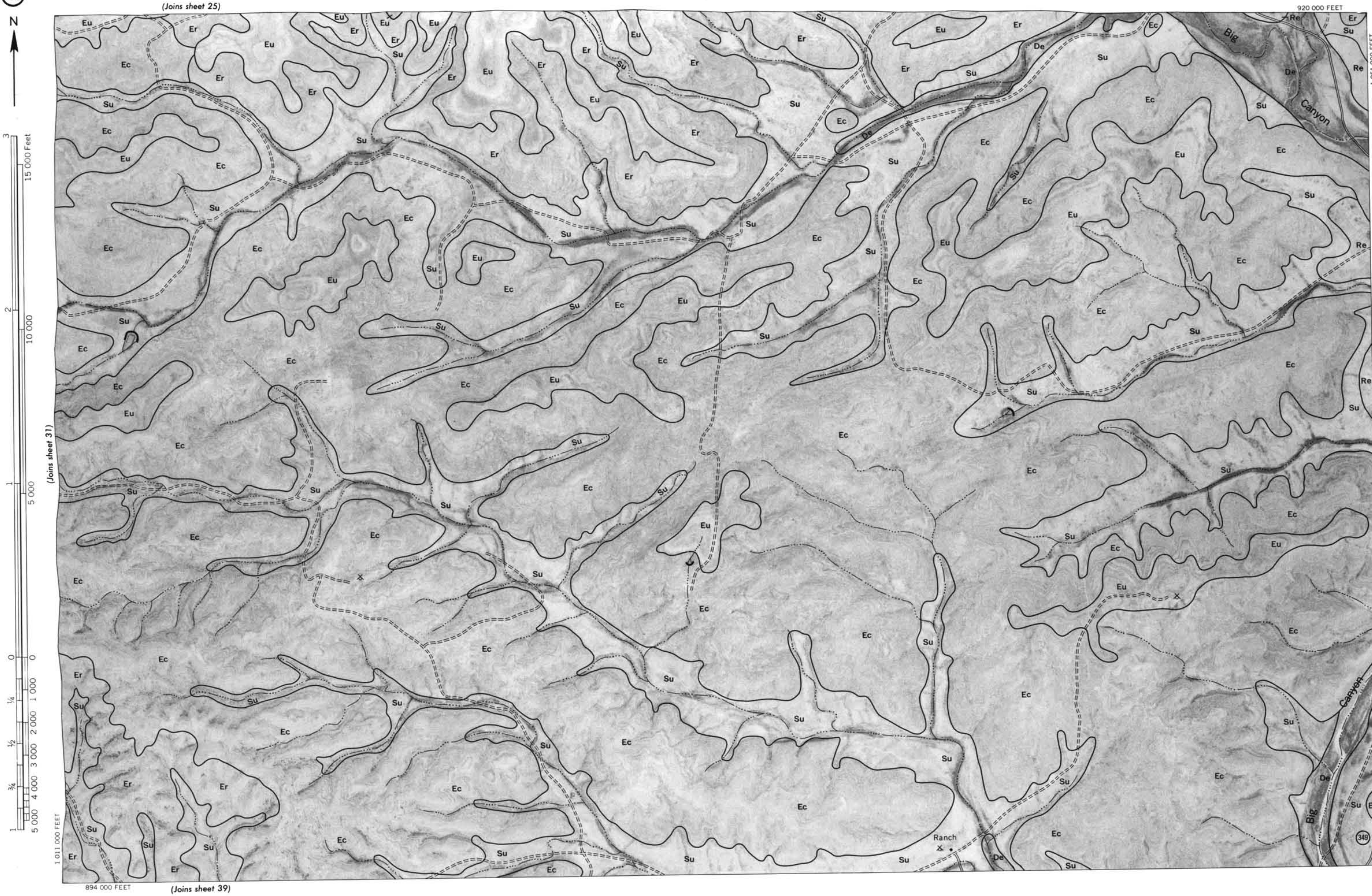
TERRELL COUNTY, TEXAS — SHEET NUMBER 32



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TERRELL COUNTY, TEXAS — SHEET NUMBER 34

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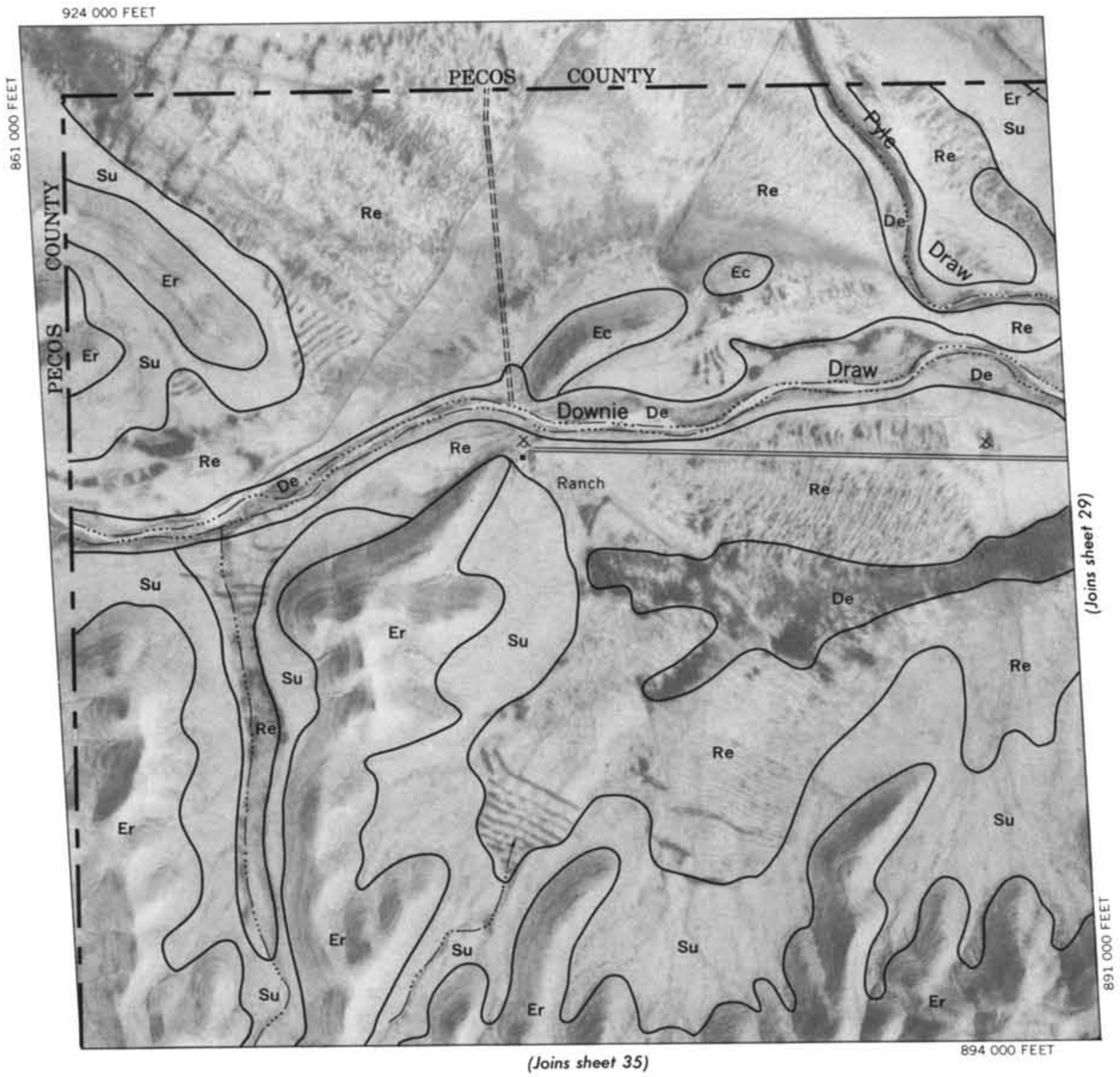
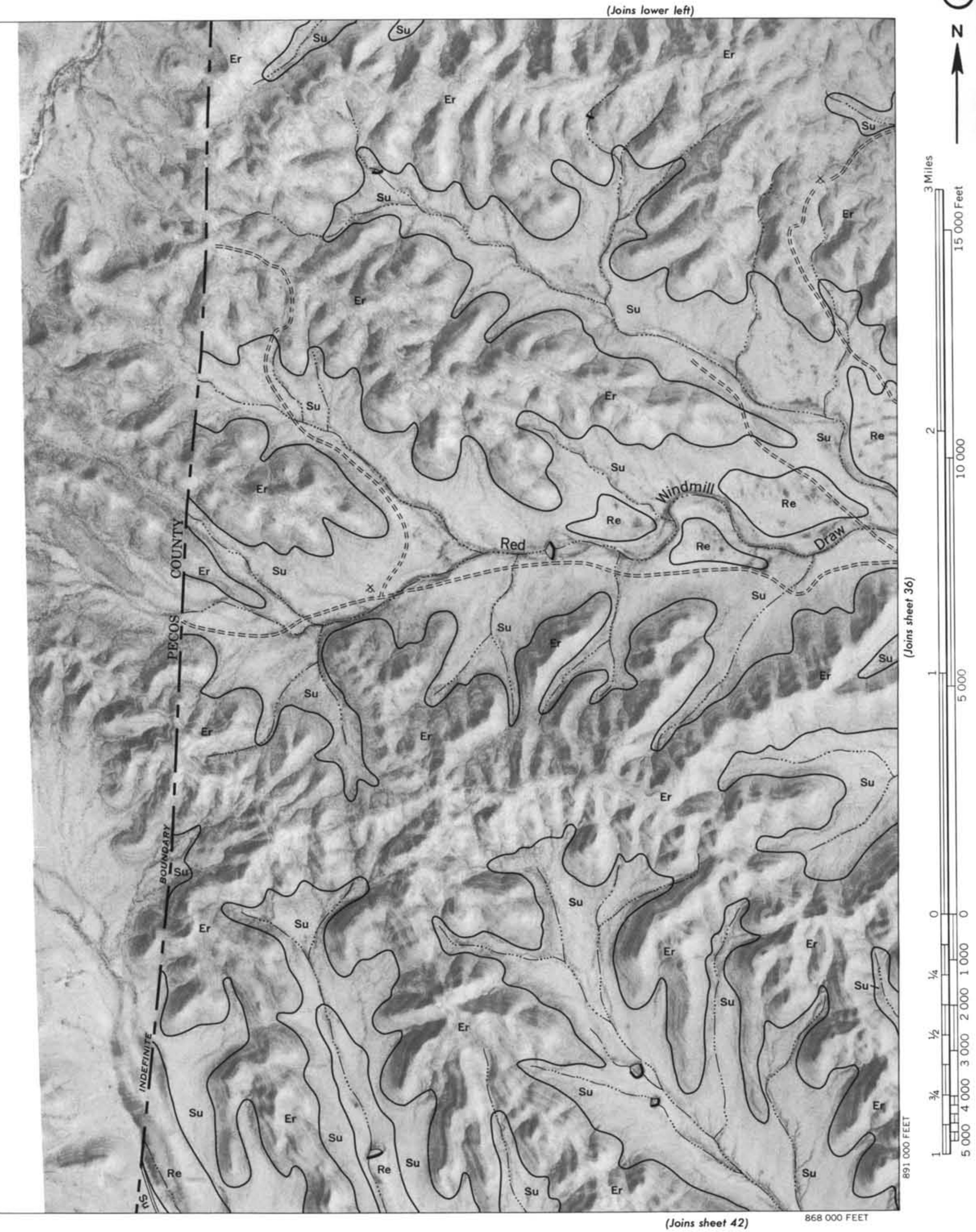
TERRELL COUNTY, TEXAS NO. 34

894 000 FEET

851 000 FEET





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This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 36

N

(Joins sheet 29)

(Joins sheet 35)

(Joins sheet 37)

(Joins sheet 43)

3 2 1 0 ¼ ½ ¾ 1
15 000 Feet 10 000 5 000 0 1 000 2 000 3 000 4 000 5 000

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 37

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 38

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 39

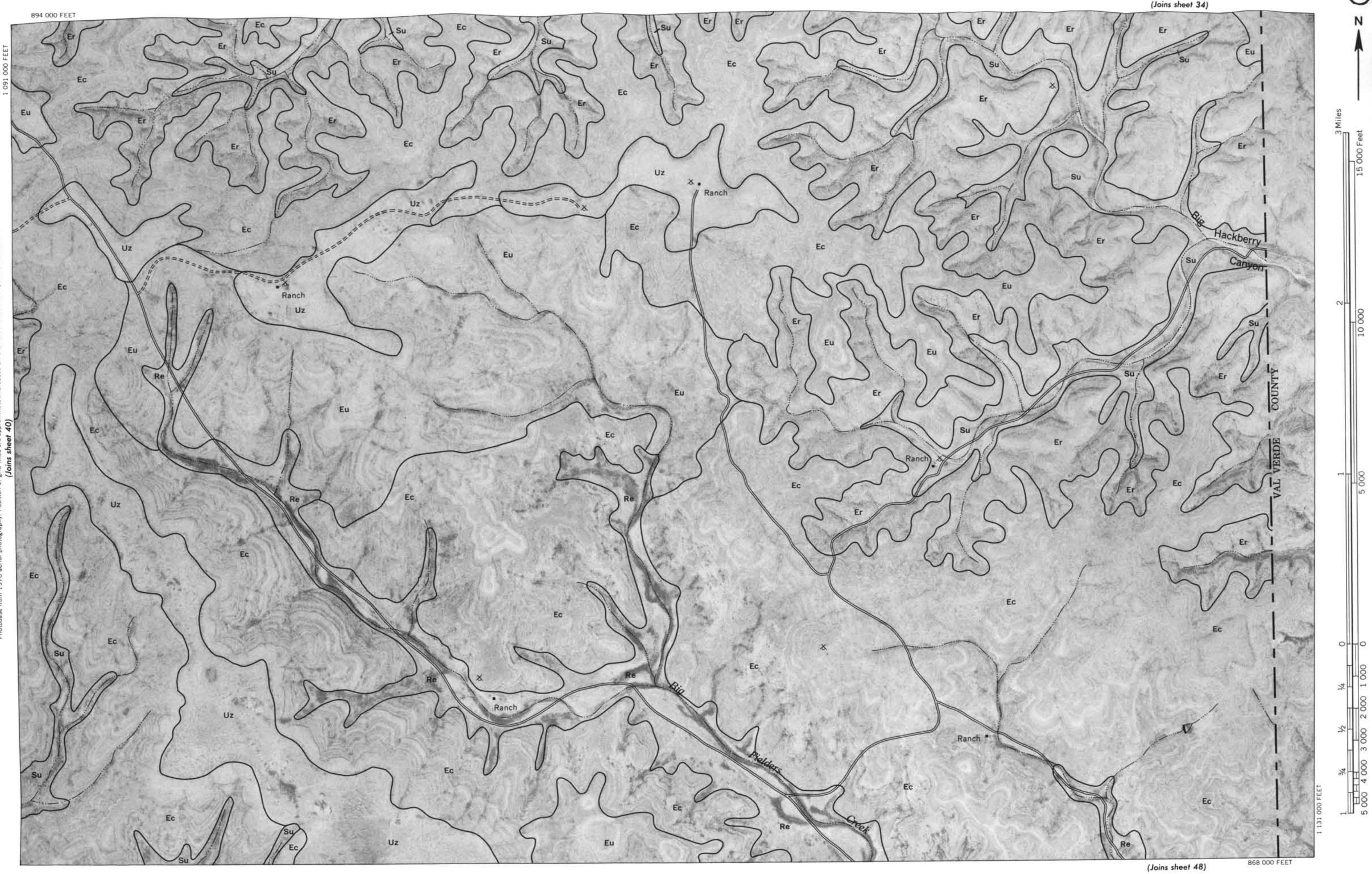
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

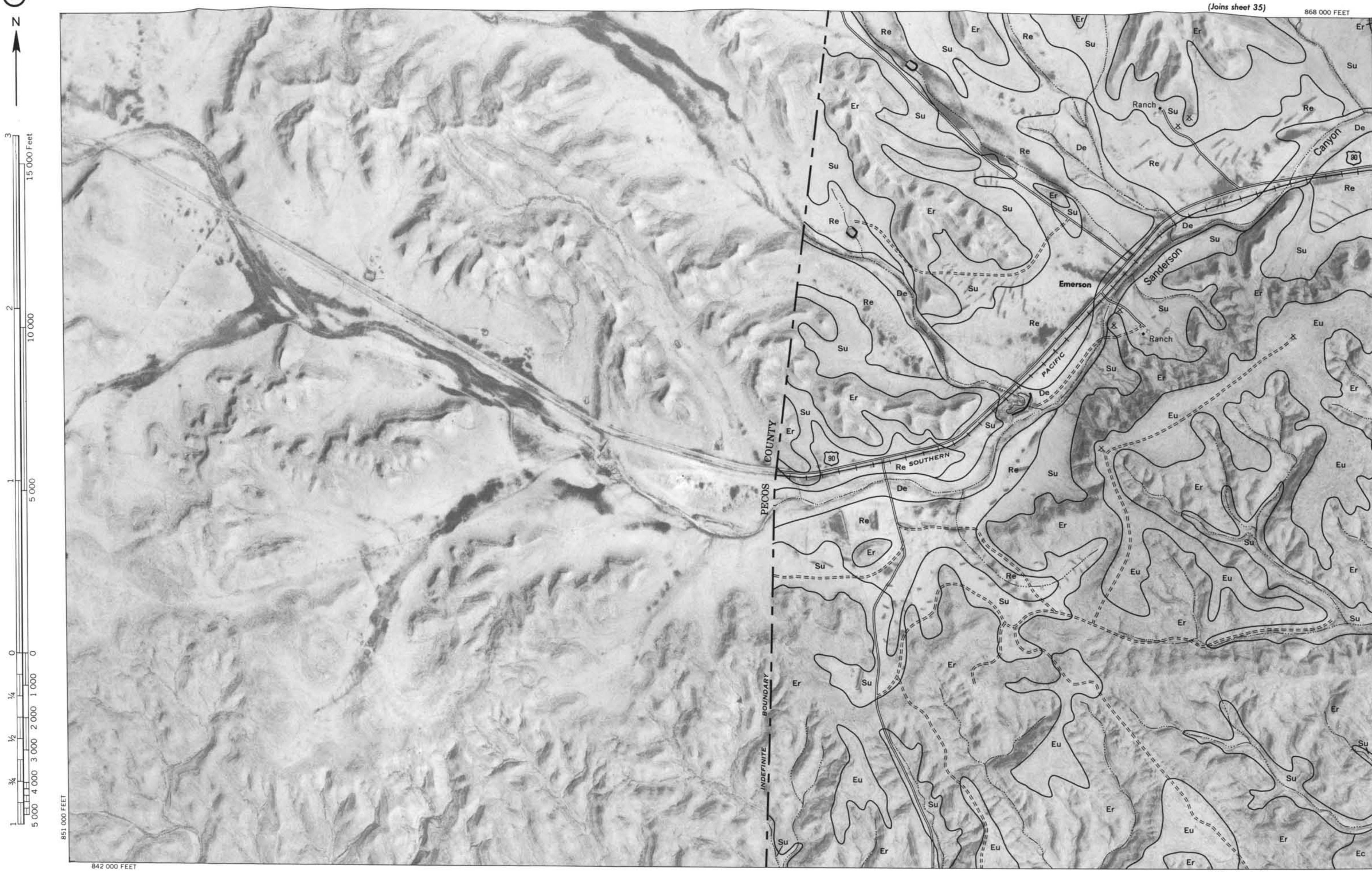
TERRELL COUNTY, TEXAS — SHEET NUMBER 40

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 41

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.





Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

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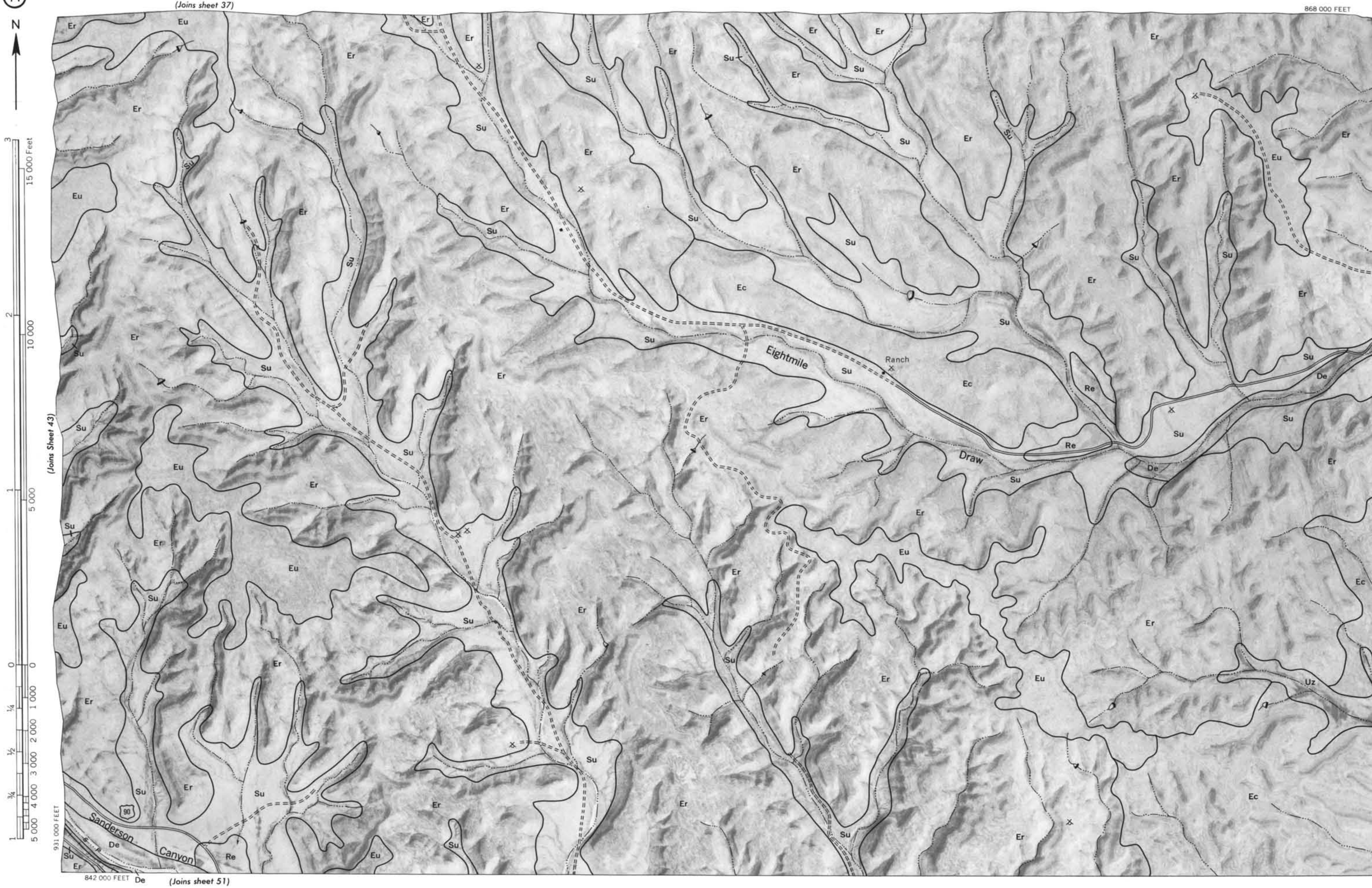
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 44



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 45

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station. Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

46

TERRELL COUNTY, TEXAS — SHEET NUMBER 46

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

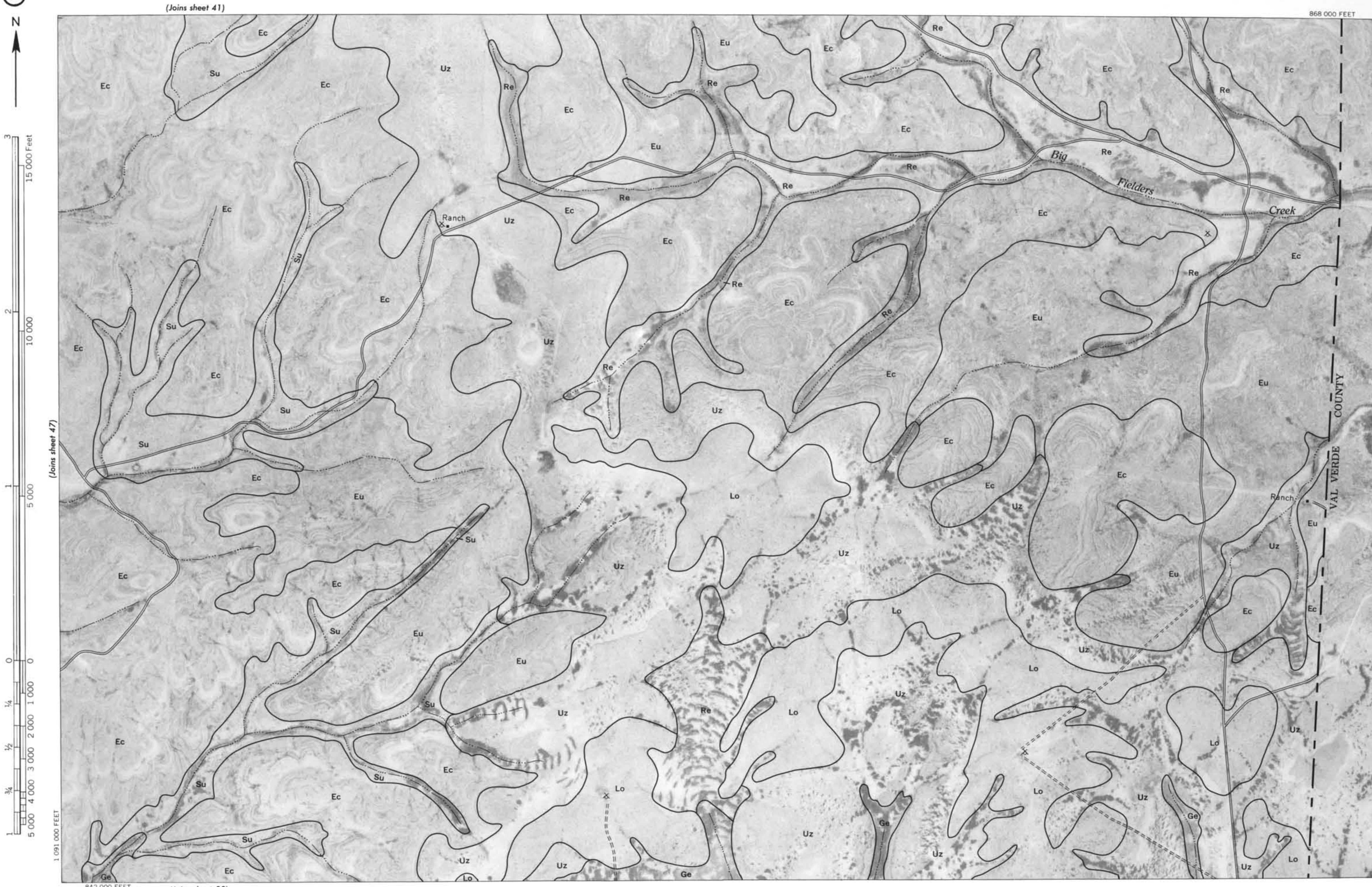
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 47

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

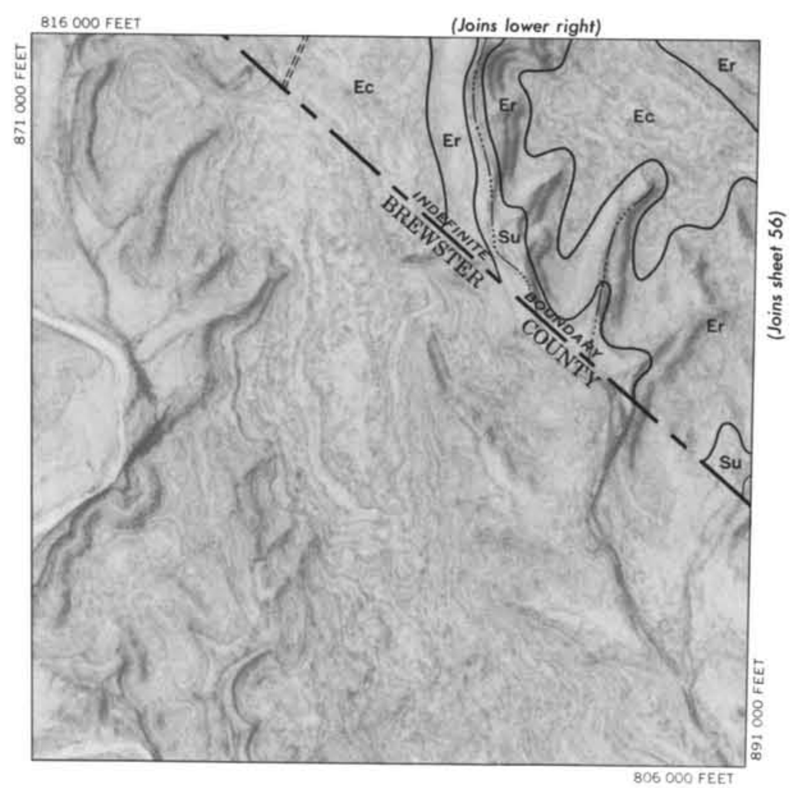
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone

TERRELL COUNTY, TEXAS — SHEET NUMBER 48



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 48

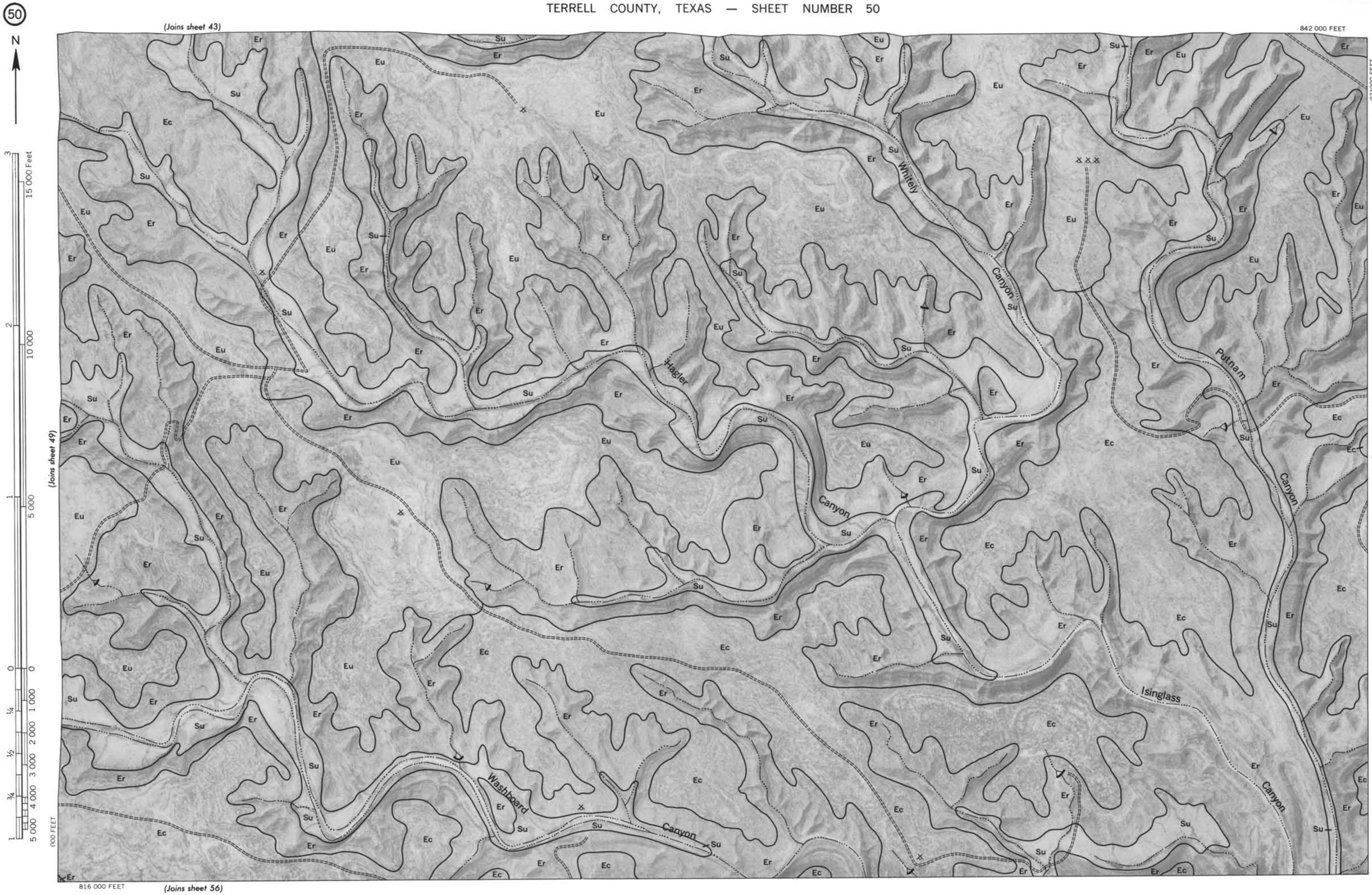


842 000 FEET

851 000 FEET

TERRELL COUNTY, TEXAS NO. 49

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

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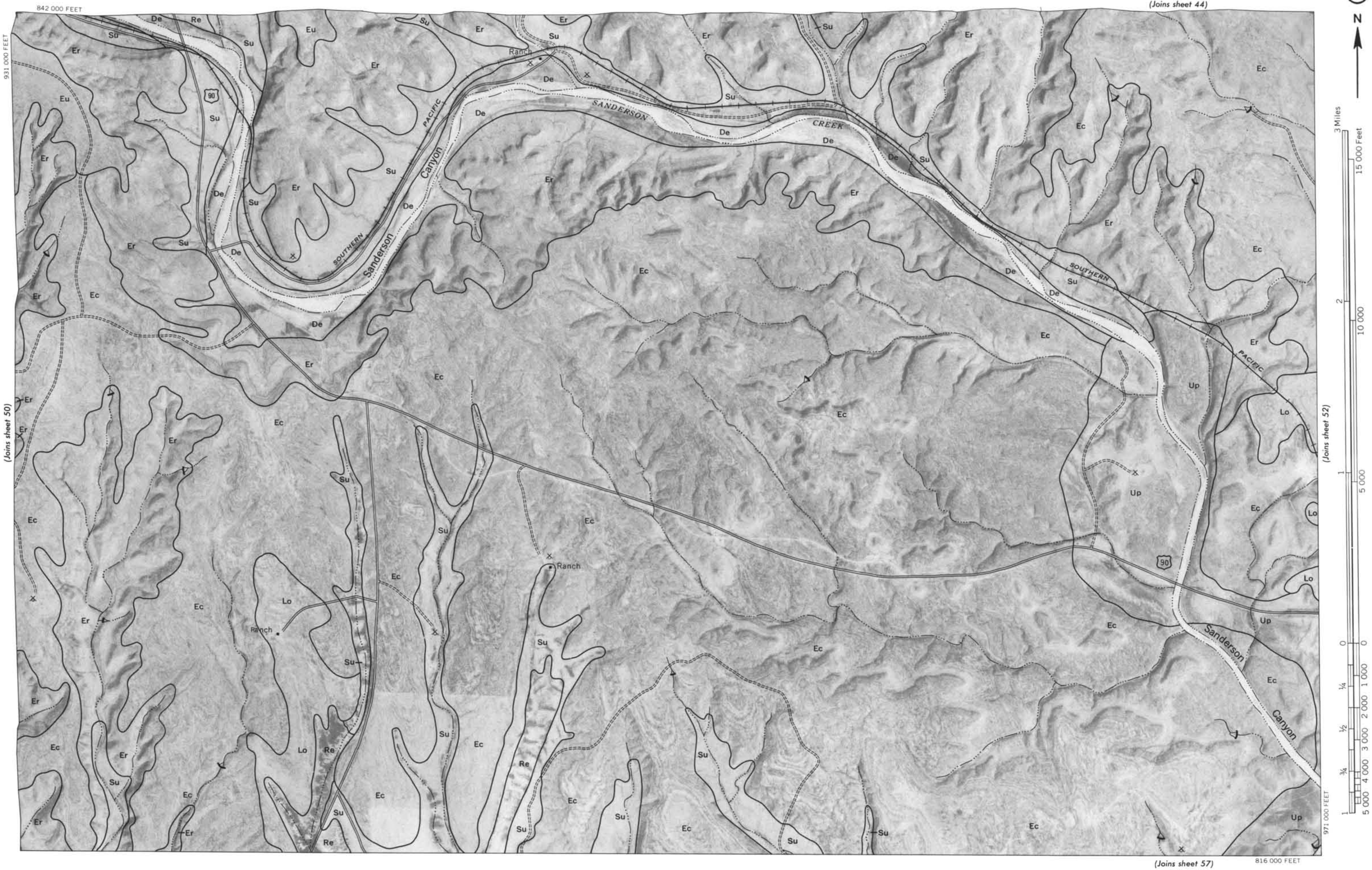
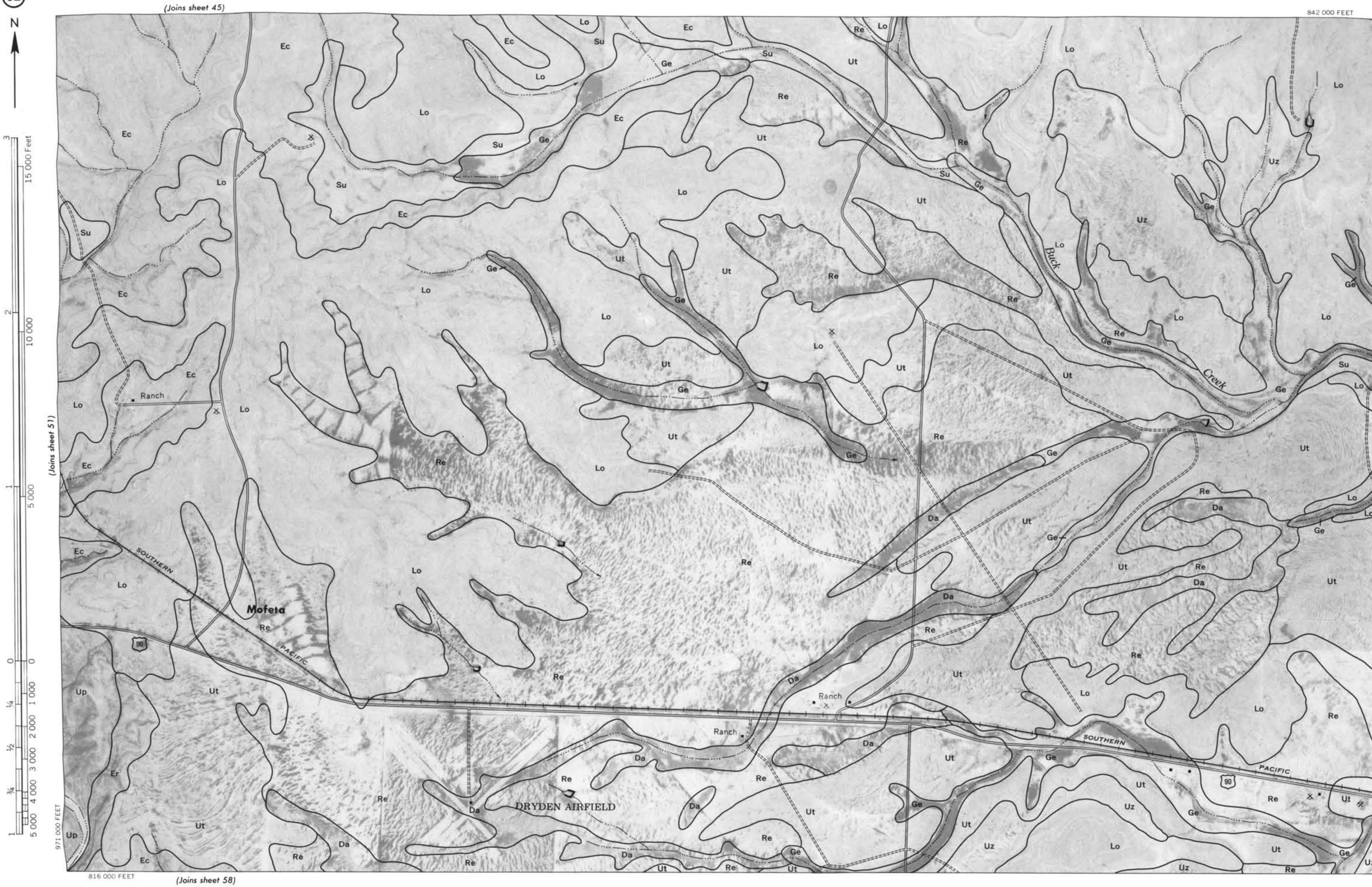
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

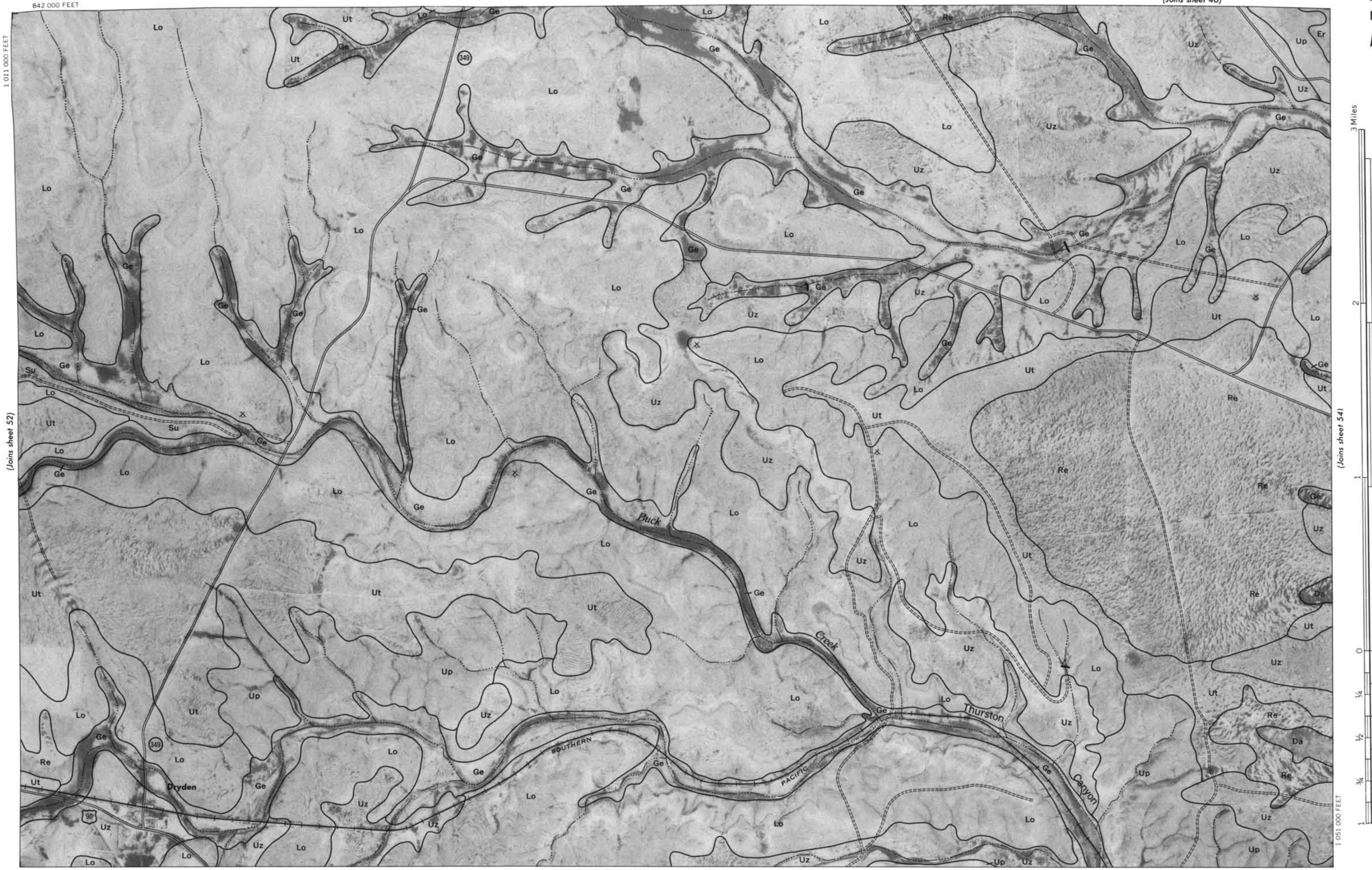


TERRELL COUNTY, TEXAS — SHEET NUMBER 52



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.



TERRELL COUNTY, TEXAS NO. 53

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station. Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone

TERRELL COUNTY, TEXAS — SHEET NUMBER 54

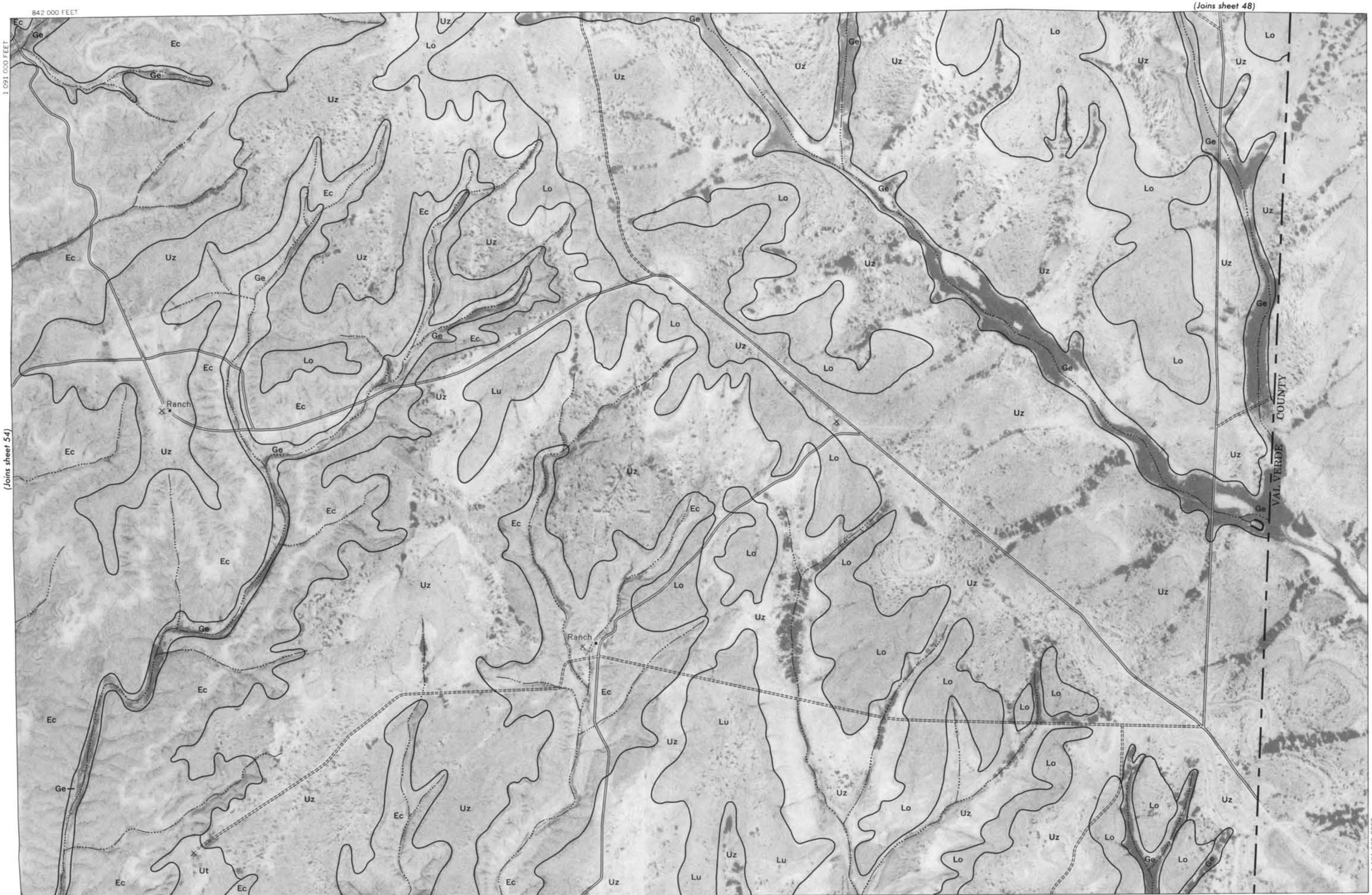
Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

55

TERRELL COUNTY, TEXAS NO. 55

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.



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15 000 Feet
10 000
5 000
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TERRELL COUNTY, TEXAS — SHEET NUMBER 56

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS — SHEET NUMBER 57

TERRELL COUNTY, TEXAS NO. 57

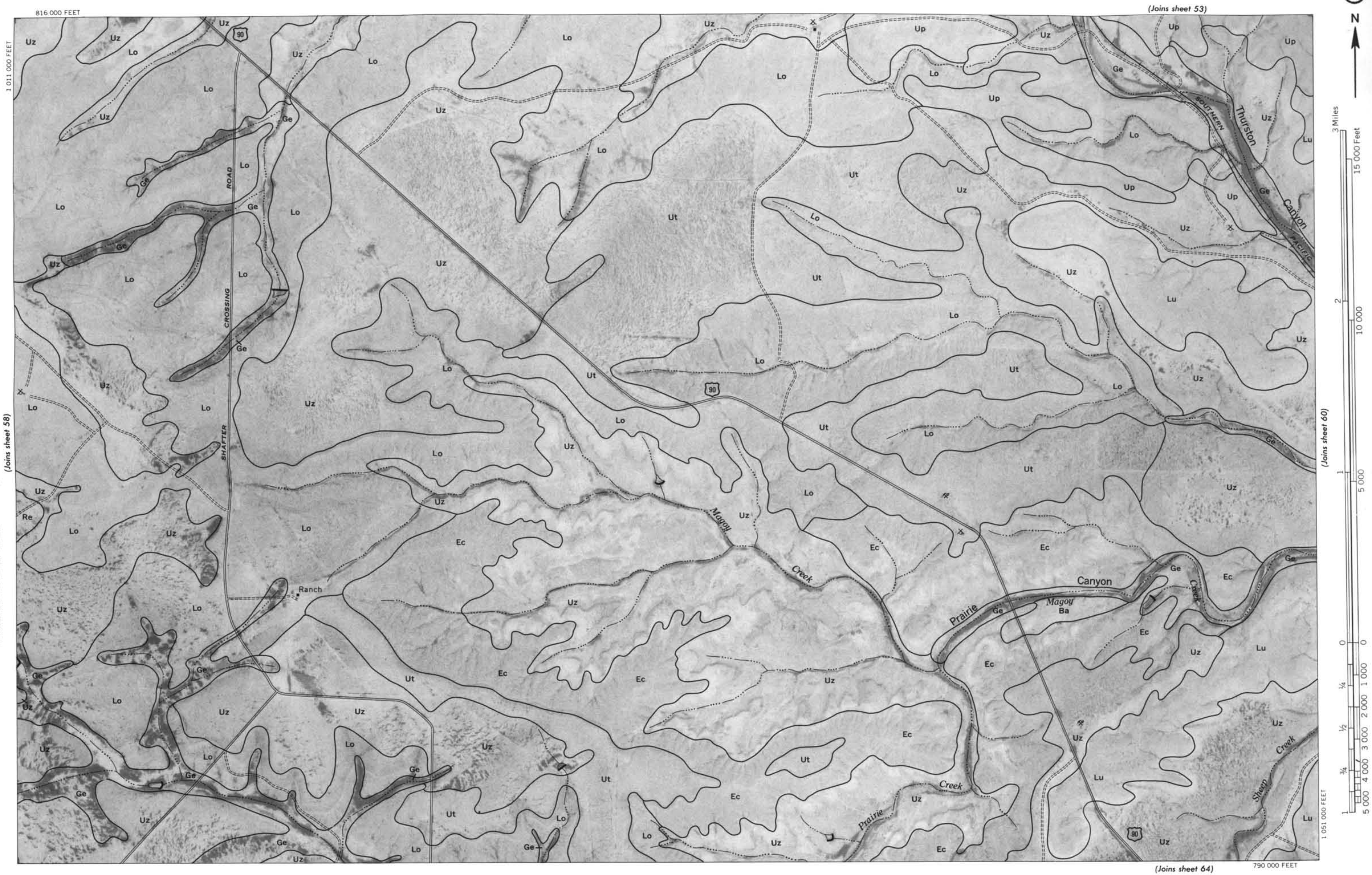
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 58

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 58



TERRELL COUNTY, TEXAS NO. 59

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 60

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

TERRELL COUNTY, TEXAS NO. 61

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

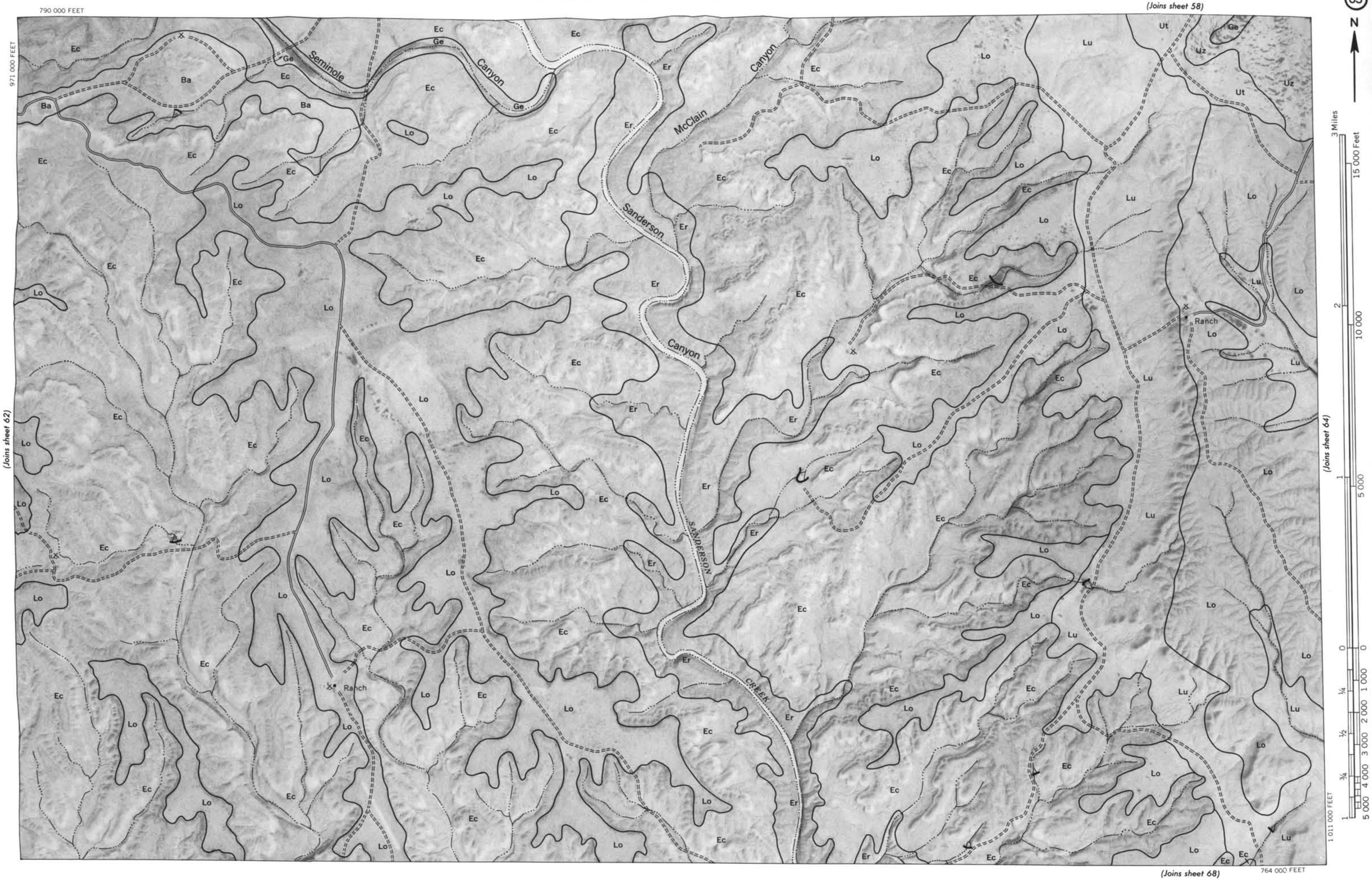
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 62

(Joins sheet 57)

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

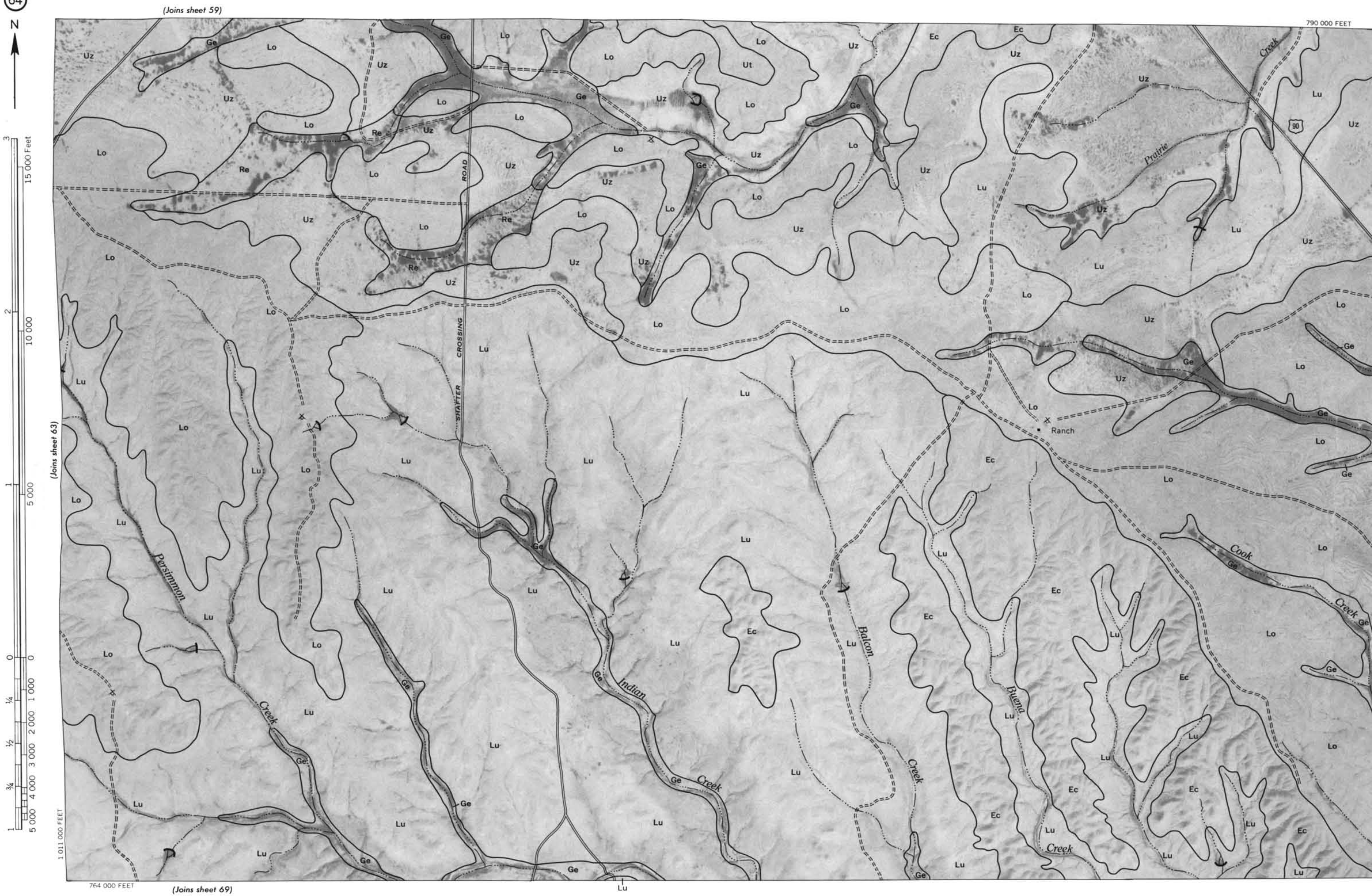
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.



TERRELL COUNTY, TEXAS NO. 63

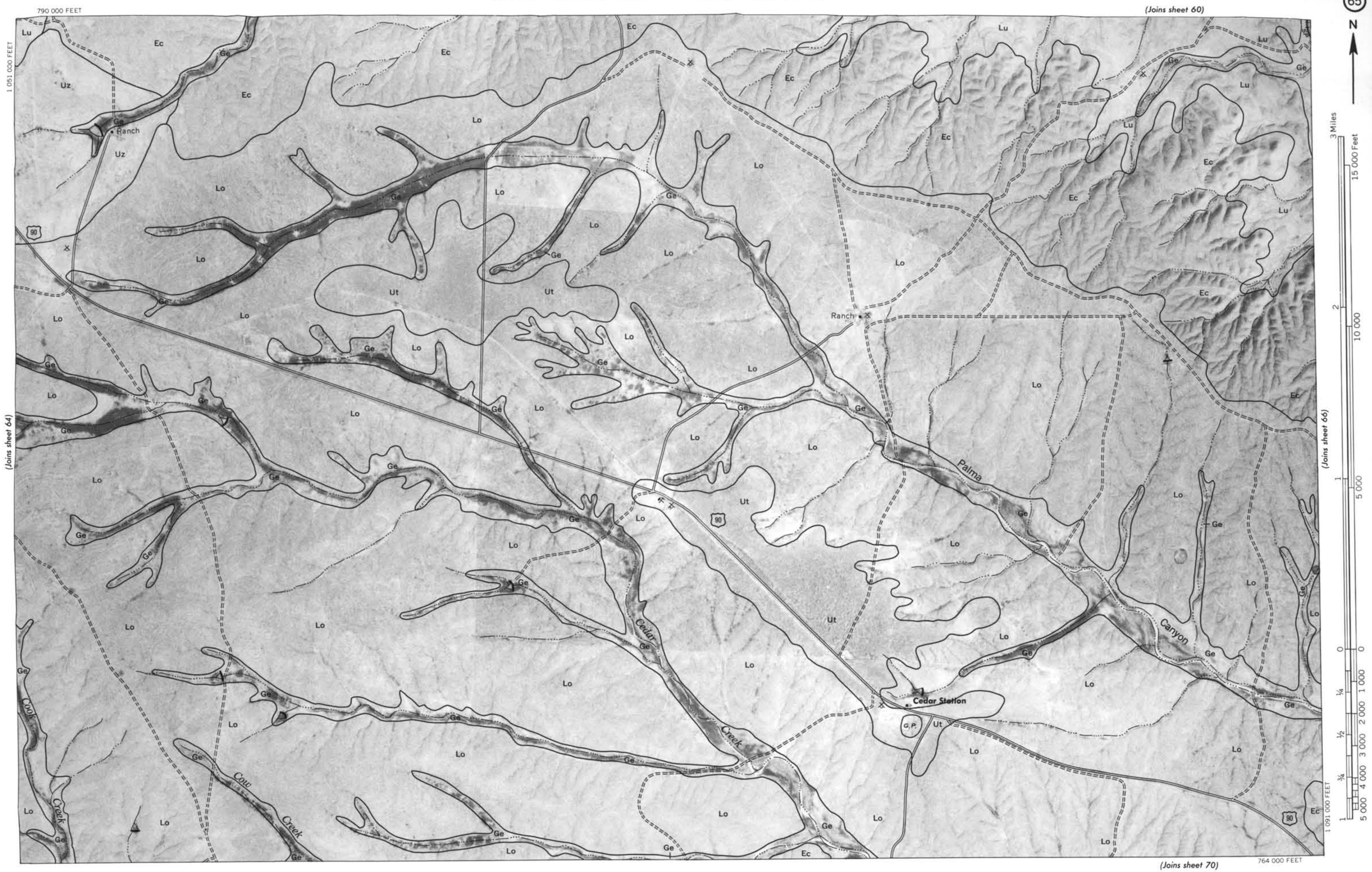
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 64



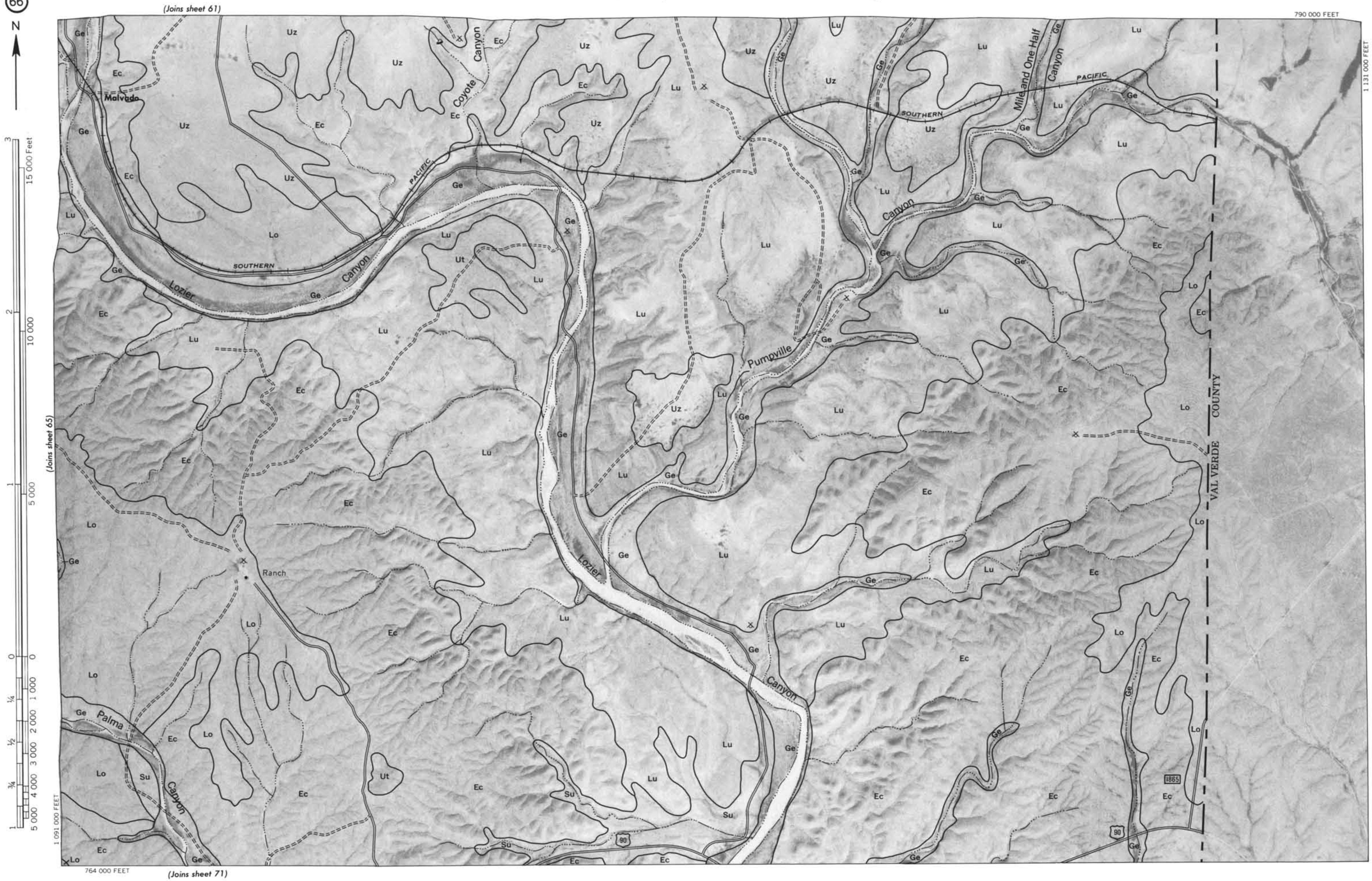
Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

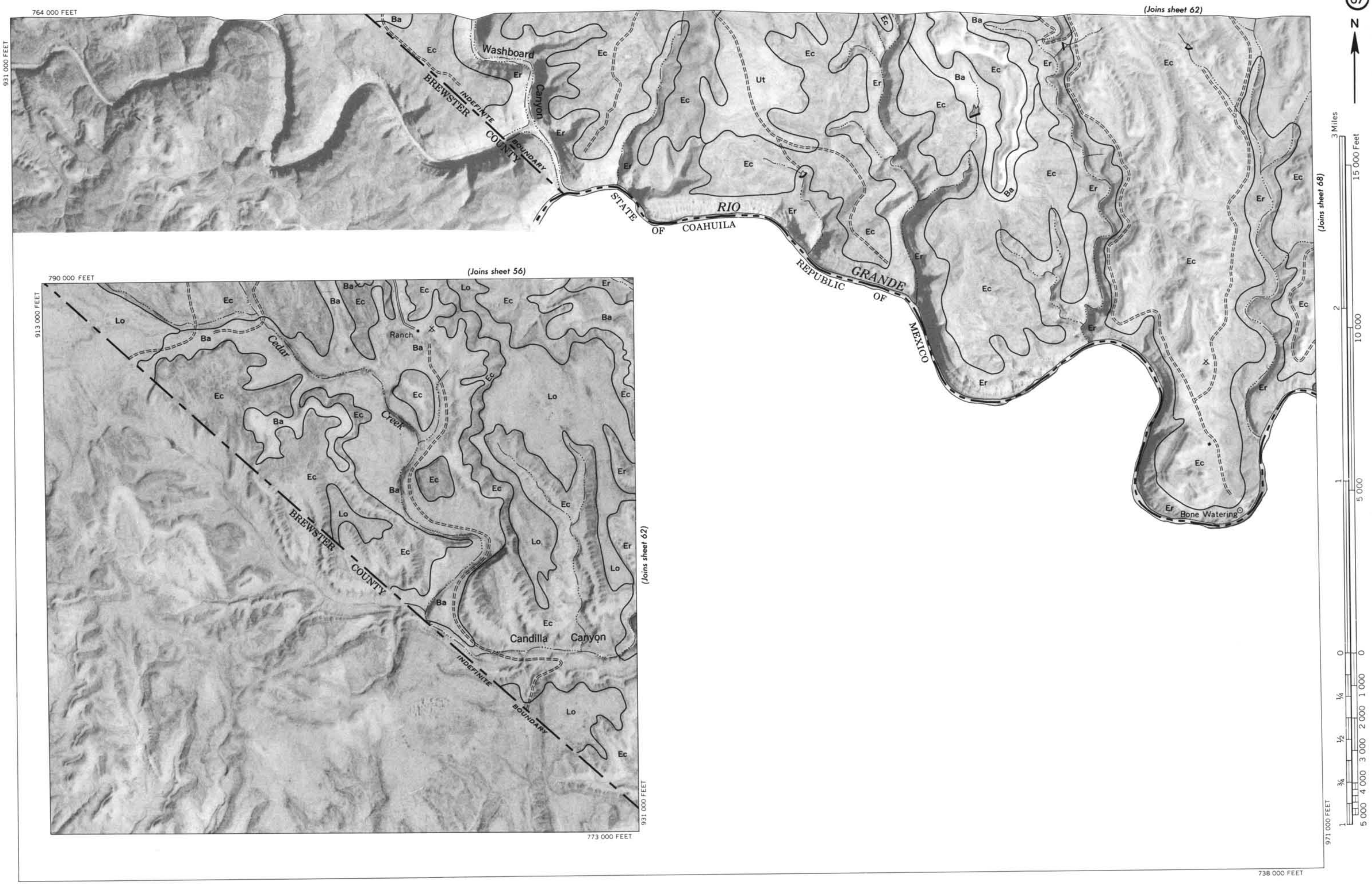


TERRELL COUNTY, TEXAS NO. 65

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.



This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

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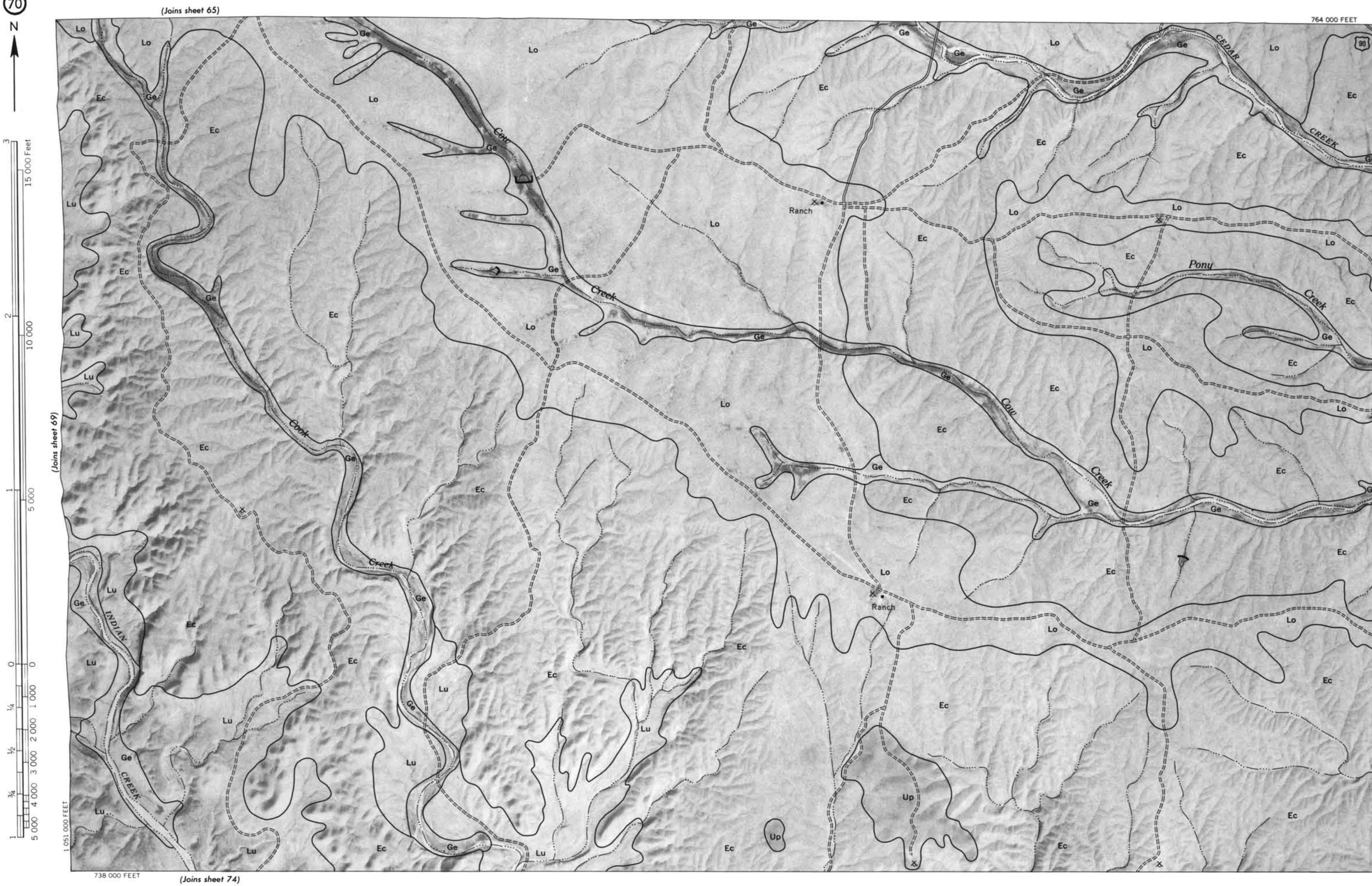
TERRELL COUNTY, TEXAS NO. 69

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 70



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

764 000 FEET

(Joins sheet 66)

1 091 000 FEET

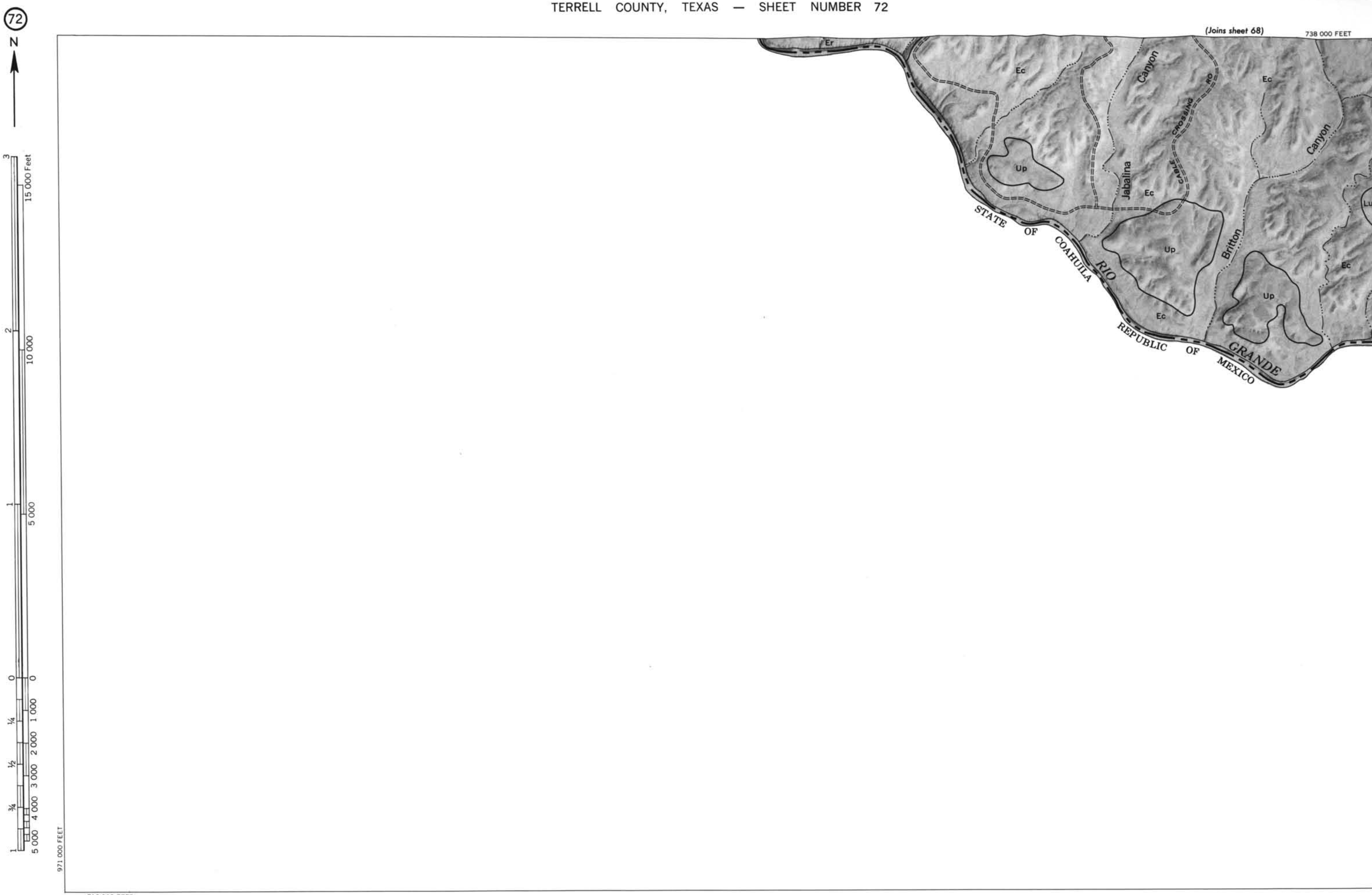
(Joins sheet 70)

(Joins sheet 75)

738 000 FEET

1 131 000 FEET

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.



Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.

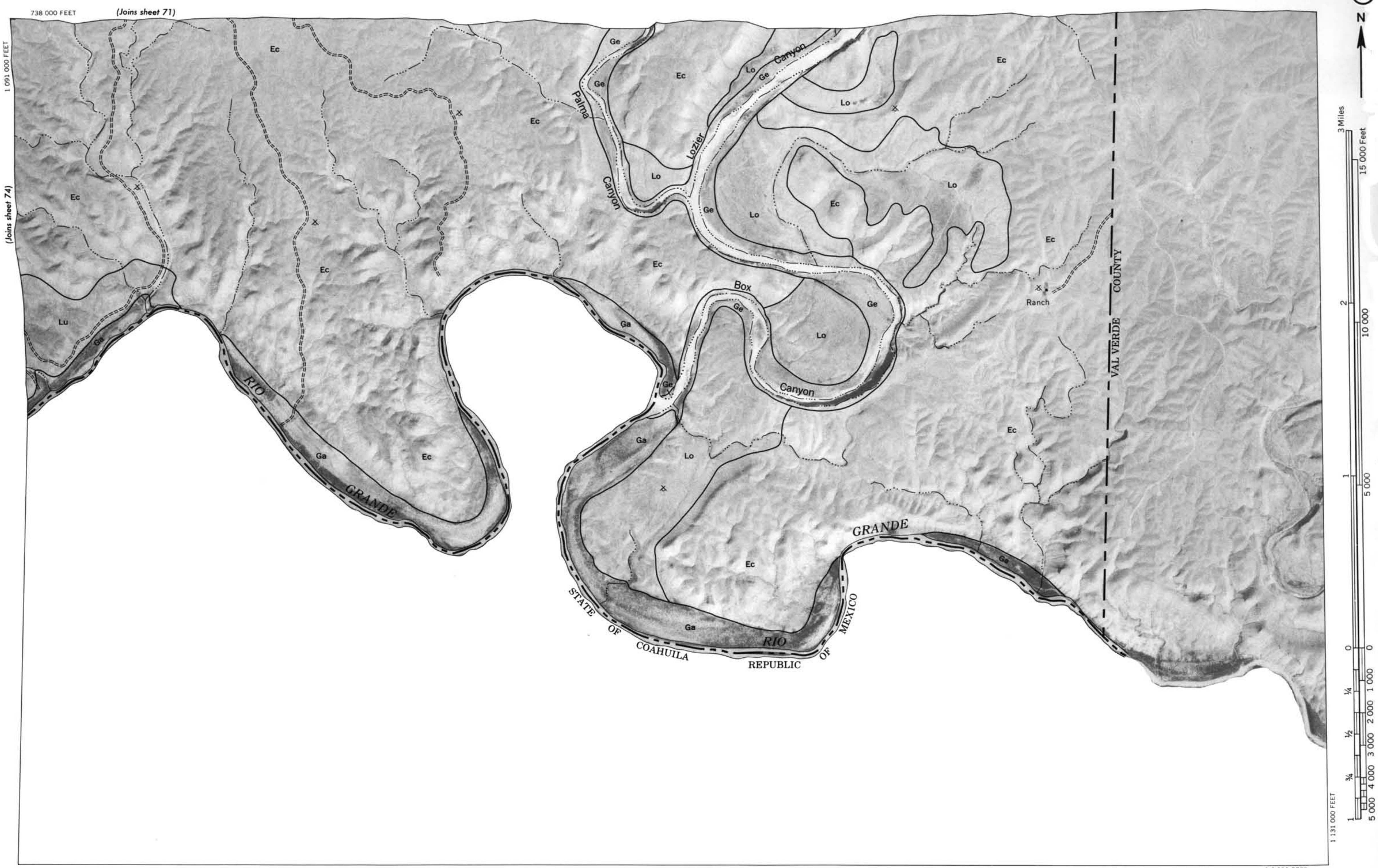
TERRELL COUNTY, TEXAS NO. 73

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.

TERRELL COUNTY, TEXAS — SHEET NUMBER 74

Photobase from 1970 aerial photography. Positions of grid lines are approximate and based on the Texas coordinate system, central zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.



TERRELL COUNTY, TEXAS NO. 75

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Texas Agricultural Experiment Station.
Photobase from 1970 aerial photography. Position of grid lines are approximate and based on the Texas coordinate system, central zone.